

WEST MAUI NATURAL AREA RESERVE
MANAGEMENT PLAN

Natural Area Reserves System
State of Hawaii

Department of Land and Natural Resources
1151 Punchbowl Street
Honolulu, Hawaii 96813
April 1989



Table of Contents

West Maui Natural Area Reserve

EXECUTIVE SUMMARY	ii
ACKNOWLEDGEMENTS	iii
I. INTRODUCTION	1
II. RESOURCES SUMMARY	3
A. General Setting	3
B. Flora	8
C. Fauna	19
III. MANAGEMENT	21
A. Key Management Considerations	21
B. Management Unit Descriptions	22
C. Management Programs	28
Ungulate Control	28
Monitoring	32
Non-Native Plant Control	33
Public Education and Volunteers	35
D. Boundary Administration and Special Uses	37
IV. BUDGET SUMMARY	37
V. SOURCES CONSULTED	39

Figures

1. West Maui Natural Area Reserve	2
2. Survey Area - Lihau Section	5
3. Survey Area - Panaewa Section	6
4. Survey Area - Honokowai Section	7
5. Survey Area - Kahakuloa Section	9
6. Natural Communities - Lihau Section	10
7. Natural Communities - Panaewa Section	13
8. Natural Communities - Honokowai Section	15
9. Natural Communities - Kahakuloa Section	16
10. Management Units - Lihau Section	23
11. Management Units - Panaewa Section	24
12. Management Units - Honokowai Section	26
13. Management Units - Kahakuloa Section	27

Table

1. Natural Communities of West Maui Natural Area Reserve 11

Appendices

1. Transect Specifications
2. Sample Survey Forms
3. Rare Plants of West Maui Natural Area Reserve
4. West Maui Area Vascular Plant Species List
5. Rare Species Map of West Maui Natural Area Reserve
6. Bird Species List
7. Rare Land Snail Table
8. Transect Threat Maps - Lihau Section, Panaewa Section, Honokowai Section, and Kahakuloa Section

Cover Photo - Eke Crater, West Maui Natural Area Reserve

EXECUTIVE SUMMARY

In 1970, Hawaii became one of the first states in the country to recognize the importance of its unique natural resources by establishing the State Natural Area Reserves System (NARS). Governor Waihee and the 1987 Legislature appropriated substantial new funding and legislative mandates to develop and implement a NARS management program. This plan describes the management program at the 6,702-acre West Maui Natural Area Reserve, established in 1986 by Executive Order #3329. The Reserve was established to protect a diversity of native ecosystems ranging from dry grasslands to wet 'ohi'a (Metrosideros polymorpha) forests which include bogs, montane lakes, and perennial streams.

The West Maui Natural Area Reserve consists of four separate sections in the Lahaina and Wailuku districts on the island of Maui: Lihau, Panaewa, Honokowai, and Kahakuloa. The Reserve ranges from about 700 feet elevation to 5,788 feet at the peak of Puu Kukui, the highest point in the West Maui mountains. No roads cross the Reserve, and steep terrain limits human access to a few ridge trails. The Reserve contains the headwaters and upper reaches of two major streams, Kanaha and Kahakuloa, as well as smaller streams and many tributaries.

Because of its size and inaccessibility, intensive management of key areas has been prioritized based on the biological resources they contain, and the threats to those resources. Intensive management activity will begin in the upper elevation forests above 4,000 feet, to limit the impact of feral pigs on the Reserve's most pristine portions. Pigs constitute the most severe threat currently affecting the Reserve as their rooting and wallowing destroy native plants and disturb ground cover on the forest floor.

Short fences along select ridges have effectively stopped pig movements into key upper areas of the Reserve. Pig removal by staff is planned. Improved access is planned to increase public hunting pressure in the Kahakuloa section of the Reserve. Coordination with Maui Land and Pineapple, who has an active pig removal program in adjacent lands, is planned. Other major program areas are:

- 1) Monitoring to evaluate the effectiveness of management work and track significant ecological changes, and
- 2) Non-native Plant Control of priority weeds that threaten to invade large portions of the Reserve.

A six-year implementation schedule is proposed to accomplish management objectives. An annual budget of \$70,000 will be needed to manage the Reserve over this time period. The remoteness of the Reserve necessitates extensive helicopter use. A West Maui management committee is proposed to coordinate future management activities, for the entire West Maui summit.

ACKNOWLEDGEMENTS

Several organizations and individuals contributed information, guidance, and review for this management plan. Their cooperation and support is deeply appreciated. In particular, thanks to Barri Morgan, Steve Perlman, Marie Bruegmann, and all the other hard working professionals at the Heritage Program of the Nature Conservancy of Hawaii who help prepared the resource information for the plan; Maui Division of Forestry staff Bob Hobdy and Wesley Wong who participated in and supported the inventory work; Robert Lee and members of the Natural Area Reserves System, DLNR Deputy Chairperson Libert Landgraf, Randy Bartlett of Maui Land and Pineapple, the Native Hawaiian Plant Society on Maui, Mike Williams of Maui Helicopters, and all the reviewers of the plan.

This plan is dedicated to the future cooperation of state and private landowners in protecting the biological resources of the West Maui summit area.

Finally, sincerest thanks to Governor John Waihee, the State Legislature, and DLNR Chairperson William Paty for their desire and vision to preserve Hawaii's unique natural resources, and for their support of the Natural Area Reserves System.

Michael G. Buck - Coordinator
Natural Area Reserves System

HAWAII NATURAL AREA RESERVES SYSTEM
DEPARTMENT OF LAND AND NATURAL RESOURCES
WEST MAUI NATURAL AREA RESERVE MANAGEMENT PLAN

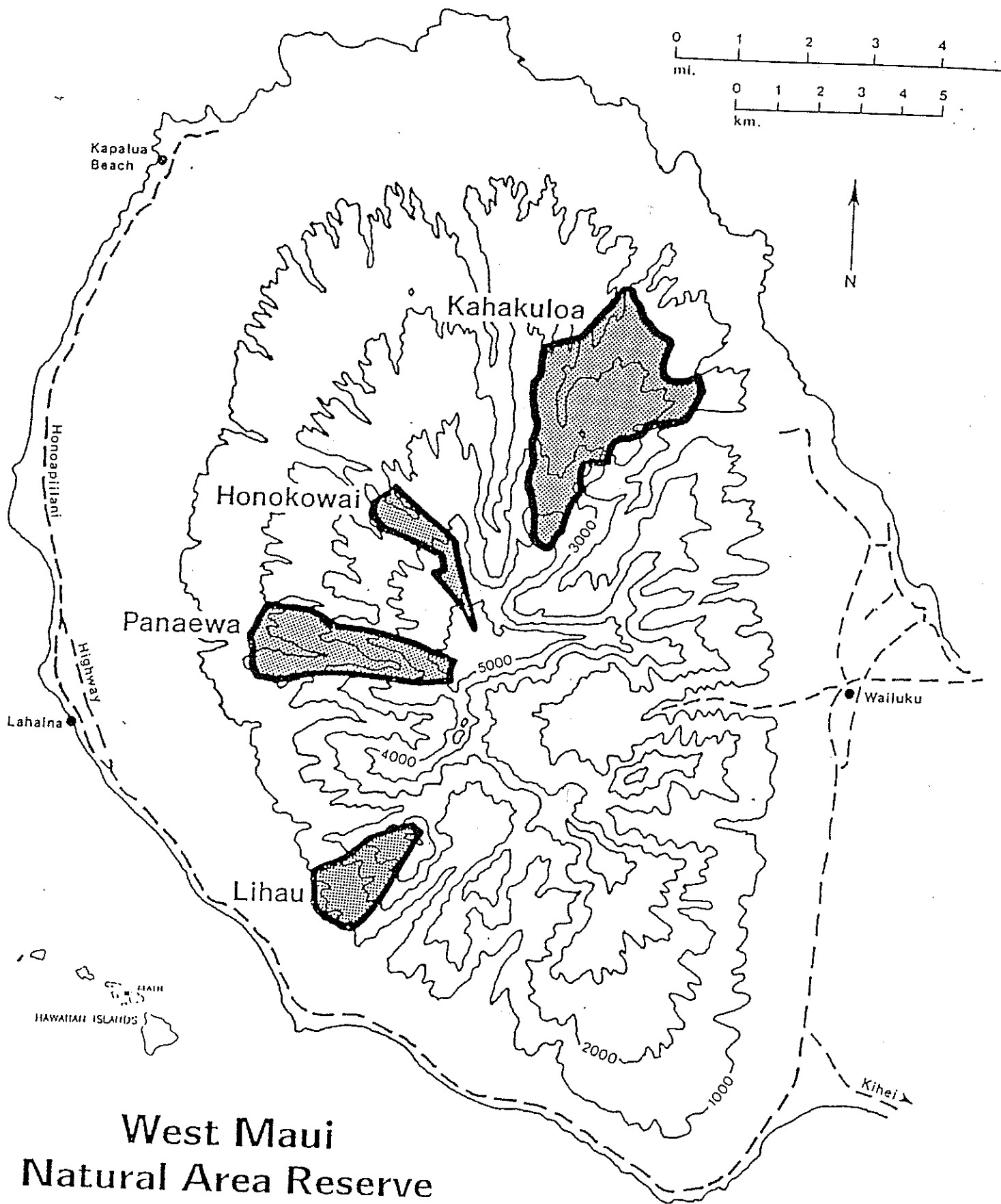
I. INTRODUCTION

In 1970, Hawaii became one of the first states in the country to recognize the importance of its unique natural resources by establishing the State Natural Area Reserves System (NARS). The NARS is legally mandated to "preserve in perpetuity specific land and water areas which support communities, as relatively unmodified as possible, of the natural flora and fauna, as well as geological sites, of Hawaii" (HRS 195-1). To date, there are 18 reserves on five islands, occupying more than 108,000 acres of the state's most biologically diverse ecosystems.

Governor Waihee and the 1987 Legislature appropriated substantial new funding and legislative mandates to develop and implement management in the NARS. Directives were given to write comprehensive management plans for each Reserve, based on the most current and relevant biological information available.

This plan describes the management program at the 6,702-acres West Maui Natural Area Reserve, established in 1986 by Executive Order #3329 (Figure 1). The Reserve was established to protect a diversity of native ecosystems ranging from dry grasslands to wet 'ohi'a (Metrosideros polymorpha) forests which include bogs, montane lakes, and perennial streams. The plan consists of five parts:

- o a brief Introduction to acquaint the reader with the project and how the plan was prepared;
- o a Resources Summary describing the Reserve's natural resources;
- o a Management plan describing programs recommended to maintain the Reserve's resources with an analysis of alternative actions and impacts;
- o a Budget Summary, listing the funds necessary to carry out the management plan; and
- o Appendices describing resource information in more detail.



West Maui Natural Area Reserve

Figure 1

Three major sources of information were used to prepare this plan. The first was The Nature Conservancy's Hawaii Heritage database on natural communities and rare species. The second was a field inventory conducted in April 1988, specifically designed to collect data relevant to management of the Reserve's natural resources. The third was a review of this plan by qualified managers, planners, and biologists familiar with the area and its problems.

Survey crews spent 12 field days during April gathering data along 11 transects, ranging from 328-12,300 feet in length, and at three supplemental stations (Appendix 1 and figures 2-5). Transects were intended to sample the range of natural vegetation units as described by J. D. Jacobi (1985). Detailed field forms were completed at sampling stations every 165 feet, noting the presence of natural communities, birds, feral ungulates, rare plants, and weeds (Appendix 2). Helicopter reconnaissance provided information on the Reserve's steeper, more remote areas.

This survey was designed to gather management-oriented resource information over a large area in a short time period and was not intended to be a comprehensive biological inventory. Sampling of small mammals, birds, and invertebrates was incidental rather than systematic. Detailed survey methods are available upon request. More comprehensive baseline surveys are needed once management activity begins in the Reserve.

This plan is intended to establish long-range goals and management priorities for the West Maui Natural Area Reserve, and to describe specific programs and activities to be accomplished during the upcoming 1989-1991 biennium. It will be updated biannually to incorporate new knowledge and refine management concepts.

II. RESOURCES SUMMARY

A. General Setting

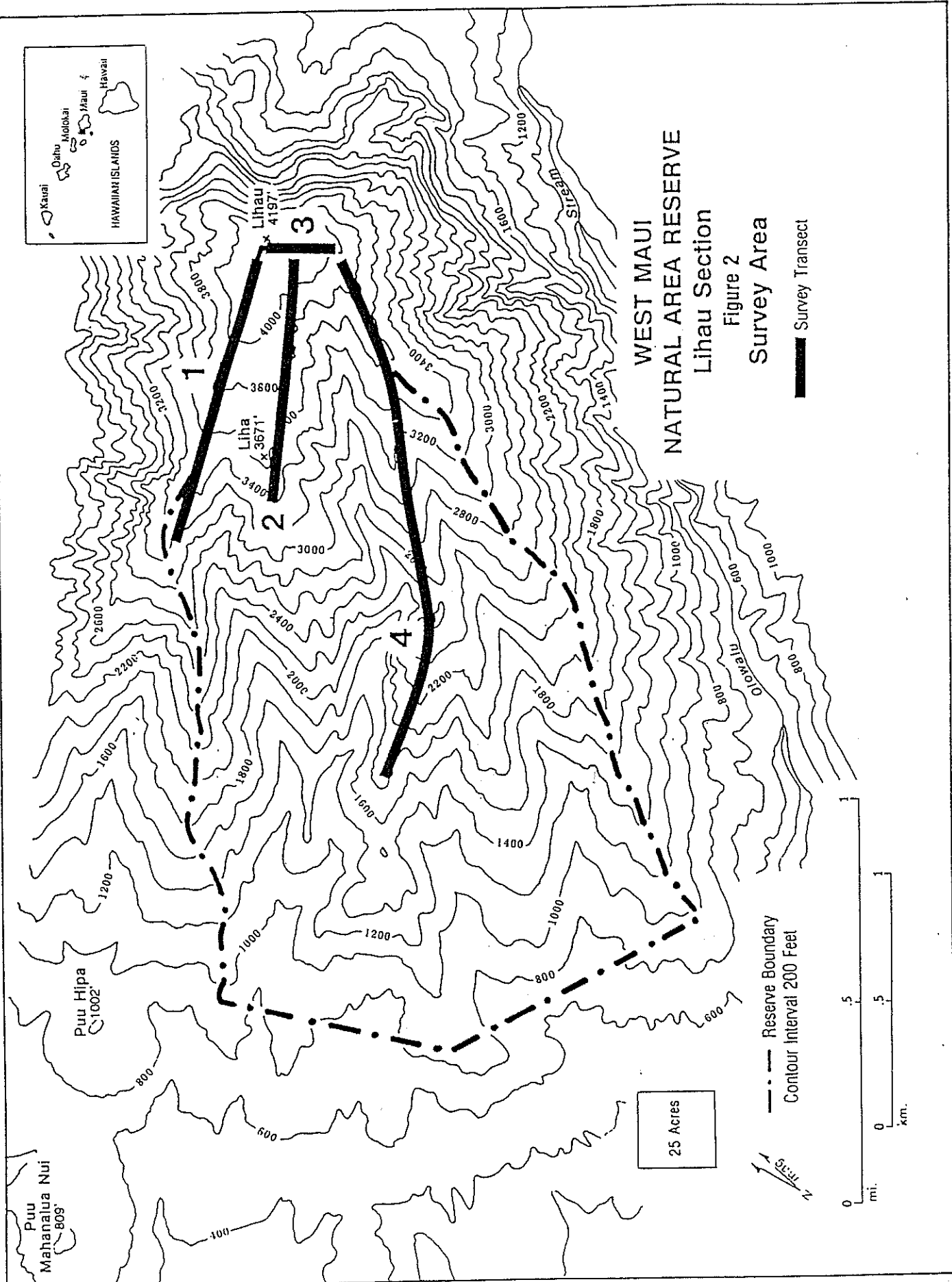
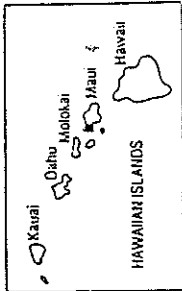
The West Maui Natural Area Reserve consists of four separate sections in the Lahaina and Wailuku districts on the island of Maui: Lihau, Panaewa, Honokowai, and Kahakuloa (Figure 1). The four sections include dry, leeward lowland areas, windward rain forests and summit bogs. The Reserve ranges from about 700 feet elevation to 5,788 feet at the peak of Puu Kukui, the highest point in the West Maui mountains. Examples of unique bog and stream ecosystems, in addition to other types of Hawaiian forests and shrublands, are found in the Reserve. No roads cross the Reserve, and steep terrain limits human access to a few ridge trails.

Each section of the Reserve is described separately in this plan, though together they make up an important part of the West Maui mountains. West Maui is virtually a separate island, geologically distinct and much older than East Maui, having been separated from the latter during prehistoric times of higher ocean levels. Extremes in precipitation (from less than 15 to more than 400 inches per year), topographic diversity, unusual lithology (both basalt and andesite-trachyte lavas are prominent), and isolation have promoted the evolution and retention of many native plants and animals, including varieties found nowhere else in the world. Regionally, the West Maui mountains are an important watershed area. The mountains contain the headwaters for 17 perennial streams, whose water discharge is one of the highest in the state within an area of comparable size. The Reserve contains the headwaters and upper reaches of two major streams, Kanaha and Kahakuloa, as well as smaller streams and many tributaries.

Lihau section consists of 960 acres with elevation ranging from just below 800 feet at the lower boundary, to 4,197 feet at the Lihau summit (Figure 2). The driest area of the Reserve, only 15 inches of rain fall annually in Lihau's lower grasslands, while its summit rain forests receive 80 inches per year. The largest population in the world of Gouania hillebrandii, a plant federally listed as endangered, is known from this section. There are no streams or trails in this section of the Reserve. The Honoapiilani Highway lies about a mile below the lower boundary near the coast.

The Panaewa section is 1,717 acres, ranging from 1,400 feet to over 5,600 feet in elevation (Figure 3). Less rain falls in the lower elevations near Paupau, increasing with elevation to make the summit near Puu Kukui extremely wet. Rare plants occur in Panaewa's bogs, forests, and shrublands which, like Lihau, have been little disturbed by feral pigs. Landmarks in the area include the three-acre burial site for Hawaiian historian David Malo, above Lahainaluna School on the section's west-central boundary. Two streams, one perennial and one intermittent (Kanaha and Halona streams, respectively) begin in the Panaewa section and flow through it to lands below.

Honokowai section encompasses 750 acres, stretching from 2,000 feet to 5,788 feet at the Puu Kukui summit (Figure 4). Rainfall in the Honokowai section reaches the second highest annual average in the state, about 400 inches at the Puu Kukui summit. Rare plants, such as the Eke silversword (Argyroxiphium caliginis), are found at the wet and boggy summit. Natural landmarks in the area include Violet Lake, Silversword Bog, Kapaloa and Amalu streams. The Puu Kukui Trail begins at 2,980 feet at the end of a jeep road at 2,980 feet, and follows the east boundary. Maui Land and Pineapple Company controls access to the Reserve, and also owns bordering areas, which are undeveloped and managed as watershed areas.



WEST MAUI
NATURAL AREA RESERVE

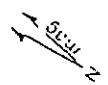
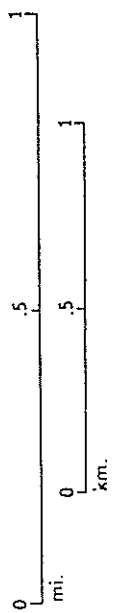
Lihau Section

Figure 2
Survey Area

Survey Transect

--- Reserve Boundary
Contour Interval 200 Feet

25 Acres

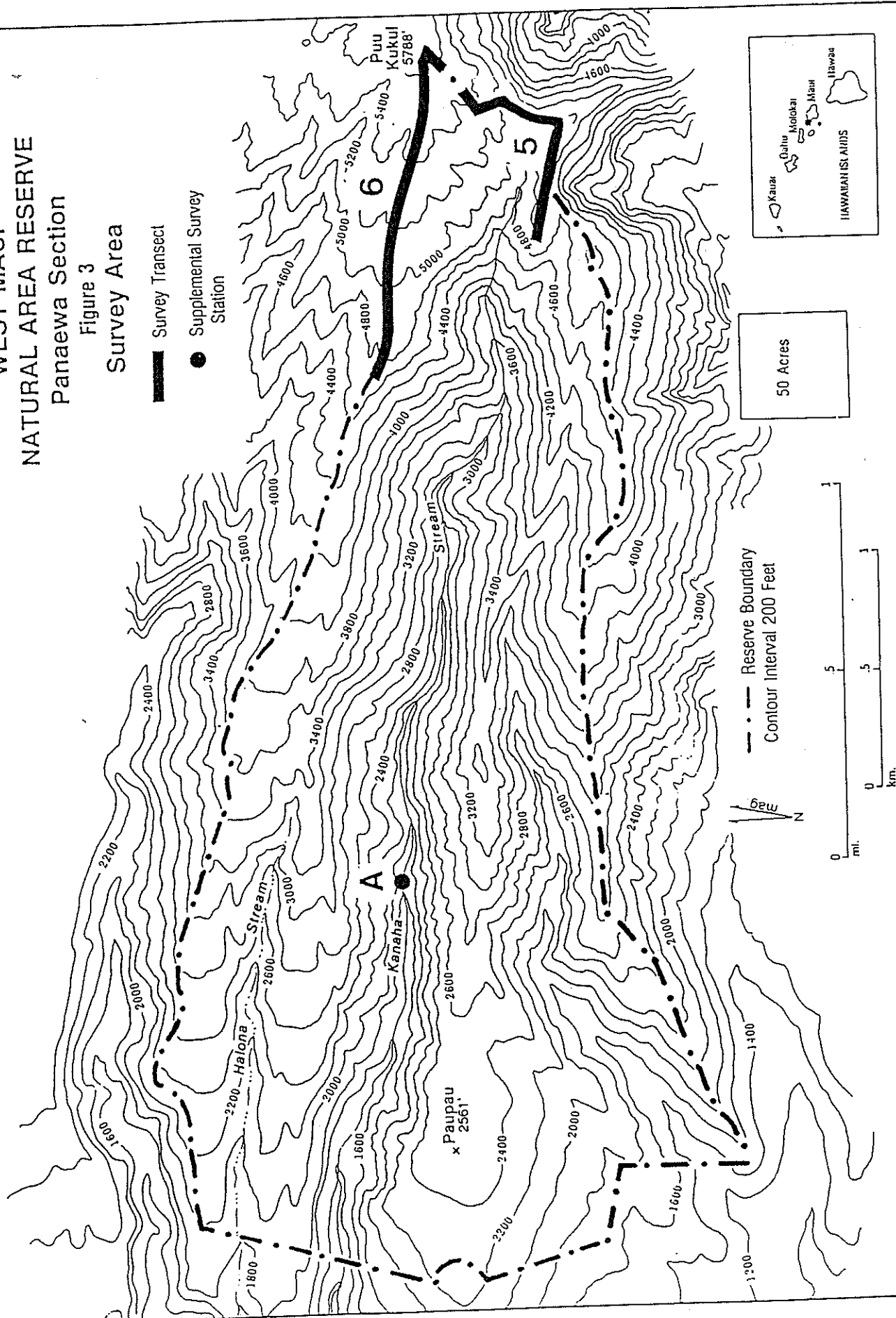


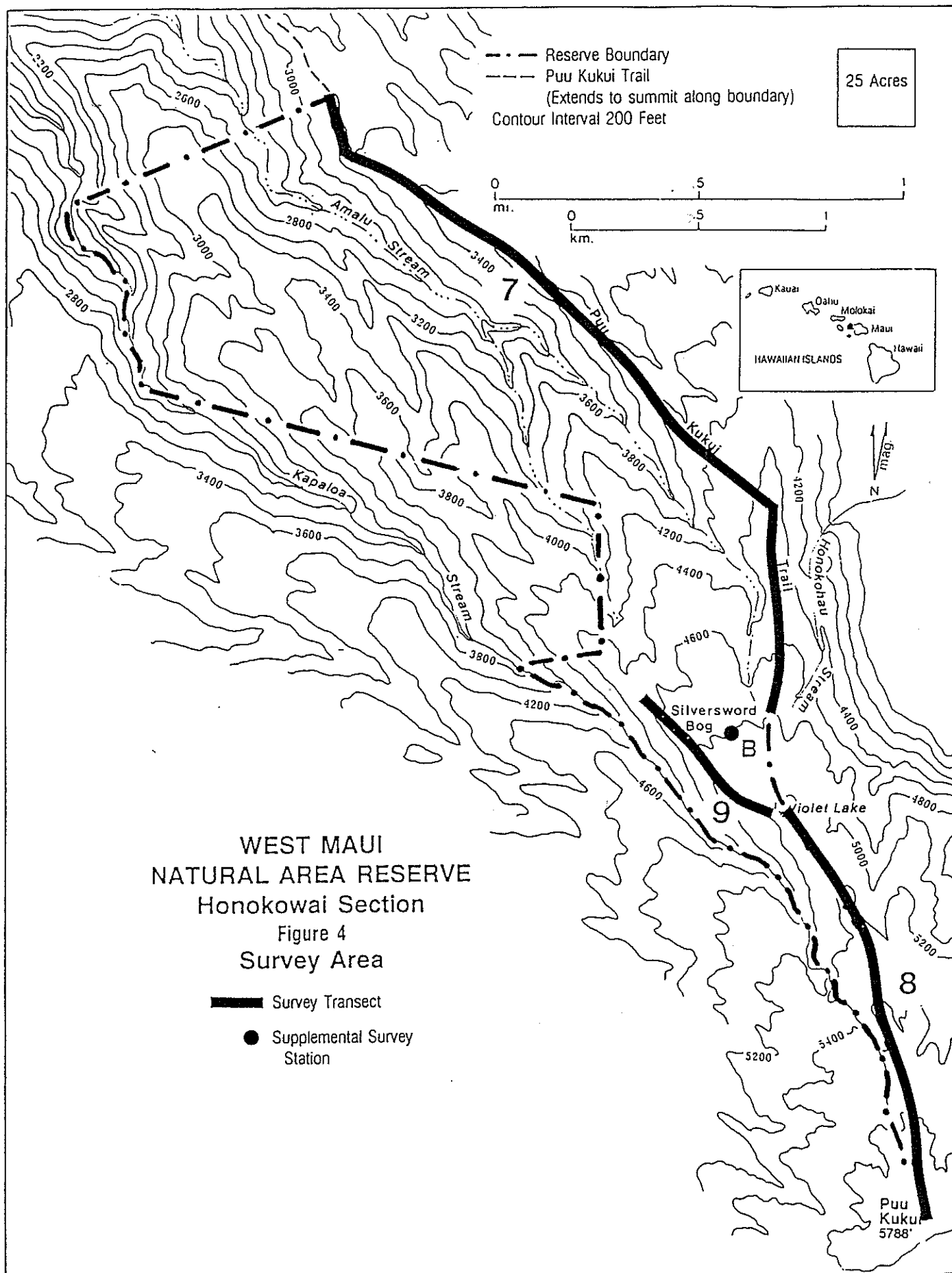
WEST MAUI NATURAL AREA RESERVE Panaewa Section

Figure 3

Survey Area

- Survey Transect
- Supplemental Survey Station





Kahakuloa, the largest section in the Reserve (3,275 acres), ranges from 550 feet at Kahakuloa Stream to 4,480 feet at Eke Crater (Figure 5). Kahakuloa Stream is one of the few perennial streams on Maui that flows undiverted to the ocean, and consequently contains a rich native aquatic fauna rarely found in the state, including fishes, molluscs, and crustaceans. The largest population of the Eke silversword (Argyroxiphium caliginis) exists on Eke Crater. Natural landmarks include Eke Crater, Lanilili Hill, Keahikauo, Puu Olelo, and Kahakuloa and Honanana gulches. Eke Trail follows the west boundary, but is little-used and poorly defined especially near Eke Crater. The West Maui Forest Reserve surrounds the section on three sides. Maui Land and Pineapple Company lands lie to the west.

B. Flora

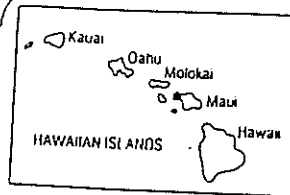
Twelve native natural communities were encountered during this survey (Table 1 and figures 6-9). Three are considered rare: Hawaiian Continuous Perennial Stream, Mixed Sedge and Grass Montane Bog, and 'Ohi'a (Metrosideros polymorpha) Mixed Montane Bog. A natural community is defined as rare when it is known from 20 or fewer locations worldwide.

About 784 acres or almost 82 percent of the Lihau section below 2,600 feet elevation, consisted of 'A'ali'i (Dodonaea viscosa) Mixed Lowland Dry Shrublands (Figure 6). Species diversity was not great in this low-statured shrubland; commonly associated species included 'ohi'a, pukiawe (Styphelia tameiameia), and ko'oko'olau (Bidens menziesii). Below 1,600 feet two native grasses, pili (Heteropogon contortus) and kawelu (Eragrostis monticola), were prominent in the understory. The non-native grass Natal redtop (Rhynchelytrum repens) became a prominent element of the understory above 1,600 feet, representing a threat to the 'a'ali'i shrubland. In adjacent gulches, small patches of the native dryland, deciduous tree, williwili (Erythrina sandwicensis) were seen.

Elevations up to 3,800 feet above the 'a'ali'i shrublands, were occupied by the 'Ohi'a Mixed Lowland Mesic Shrubland. This variable-statured shrubland, from less than 3 feet to about 6 feet in height, formed about 13 percent of Lihau section (125 acres). The associated shrubs and codominants of the shrubland included 'a'ali'i, pukiawe, and the mat ferns known collectively as uluhe (Sticherus owhyensis, Dicranopteris linearis and Diplopterygium pinnatum).

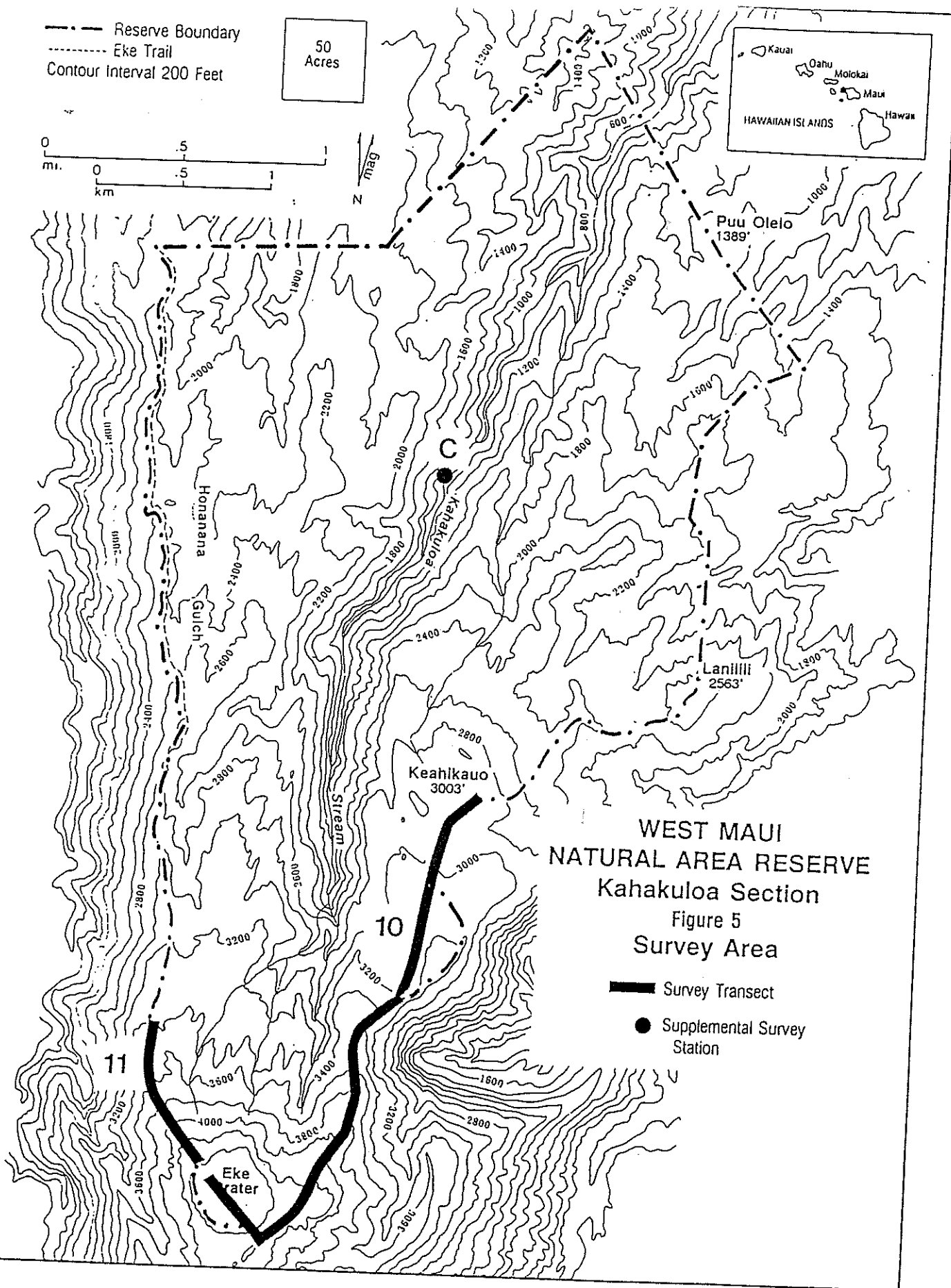
--- Reserve Boundary
--- Eke Trail
Contour Interval 200 Feet

50
Acres



0 .5 1
mi.
0 .5 1
km

N
mag



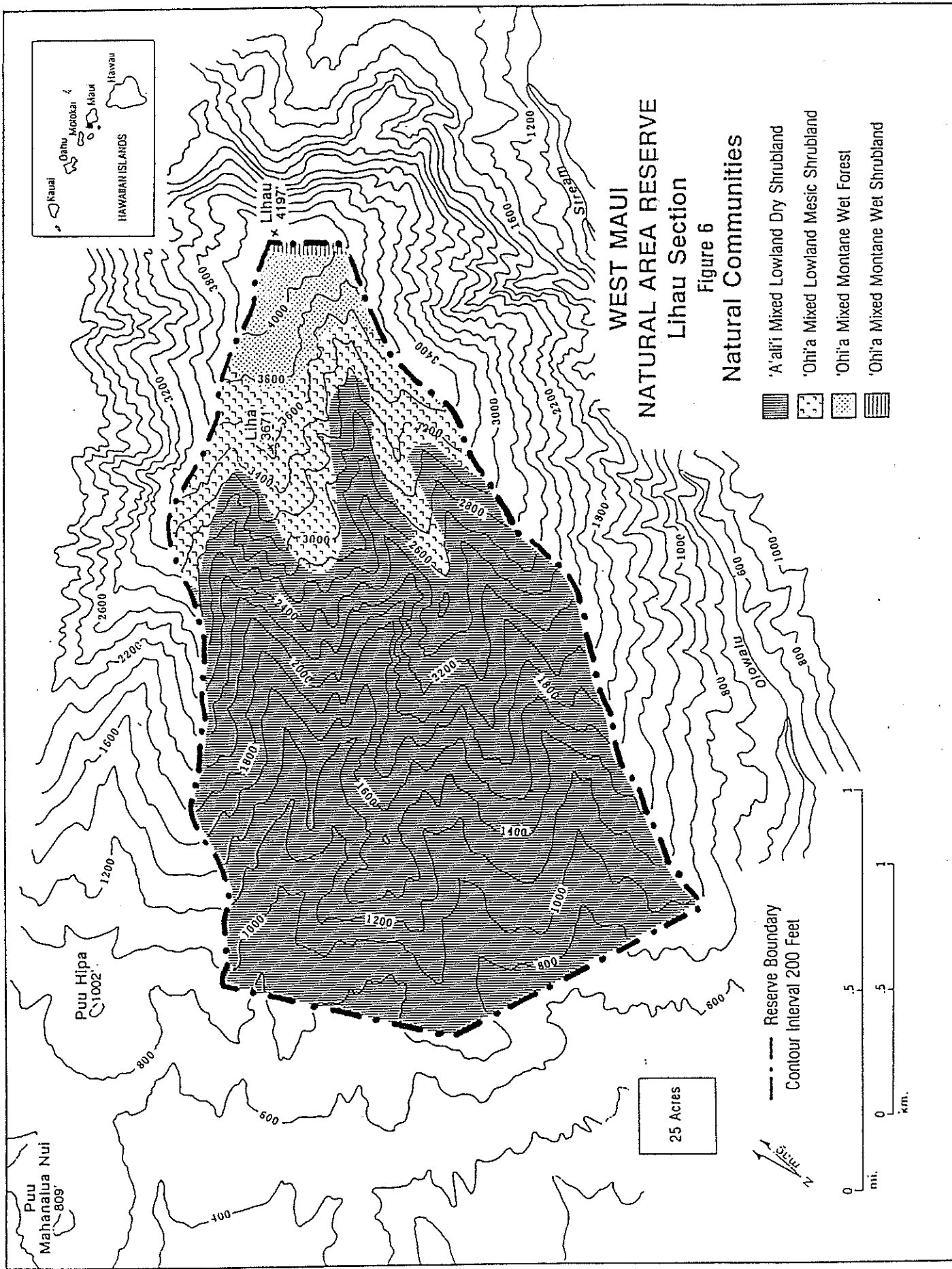


TABLE 1
NATURAL COMMUNITIES OF WEST MAUI NATURAL AREA RESERVE

Community Name	HHP Rank ¹	Section
'A'ali'i Mixed Lowland Dry Shrubland	3	L
* Hawaiian Continuous Perennial Stream	1	K
Hawaiian Montane Lake	3	H, K
Mamaki Lowland Wet Shrubland	3	K, P
Mixed Fern/Shrub Montane Wet Cliffs	3	H, K, P
* Mixed Sedge and Grass Montane Bog	1	H
'Ohi'a Mixed Lowland Mesic Shrubland	3	L, P
* 'Ohi'a Mixed Montane Bog	2	H, K, P
'Ohi'a Mixed Montane Wet Shrubland	3	L, H, K, P
'Ohi'a Mixed Shrub Montane Wet Forest	3	K, H
'Ohi'a/'Olapa Montane Wet Forest	3	L, H, K, P
'Ohi'a/Uluhe Montane Wet Forest	3	L, H, K, P

* Rare Natural Community

¹ Key to Hawaii Heritage Program Ranks:

- 1 Critically imperilled globally (typically, 1-5 occurrences)
- 2 Imperilled globally (typically 6-20 occurrences)
- 3 Restricted range (typically 21-100 occurrences)

A mosaic of 'ohi'a-dominated montane wet forest types made up about 5 percent, or 48 acres of the Lihau section above the 'ohi'a lowland mesic shrublands (Figure 6). One constituent of the mosaic, the 'Ohi'a Mixed Shrub Montane Wet Forest, is generally characterized by lack of a codominant tree, but has a rich mixture of understory shrub species. In the Lihau section, this forest occupied only the immediate summit regions. At exposed sites canopy stature was low (5-15 feet), while at more protected sites the canopy was higher (15-30 feet). Common species in the mixed shrub layer included pu'ahanui (Broussaisia arguta), alani (Pelea clusiifolia), kolea (Myrsine spp.), kawa'u (Ilex anomala), and 'ohelo (Vaccinium calycinum). Fern and bryophyte diversity was very high both on the ground and as epiphytes.

'Ohi'a/'Olapa (Cheirodendron trigynum) Montane Wet Forest also formed part of this 'ohi'a-dominated mosaic in Lihau, mostly on the tops of ridges. Cover of 'ohi'a and 'olapa varied; the canopy was generally open and low (5-15 feet). Common species included kawa'u, pu'ahanui, 'ohelo, alani, pilo (Coprosma ochracea), kolea, and a rich variety of ground and epiphytic ferns, liverworts and mosses. The only sighting of the native honeycreeper, 'I'iwi (Vestiaria coccinea), occurred in this forest type during the survey. 'Apapane (Himatione sanguinea) were numerous in the canopy. 'Ohi'a/Uluhe Montane Wet Forest formed the third part of

this mosaic; it included patches dominated by each of the three major uluhe ferns (Sticherus owhyensis, Dicranopteris linearis and Diplopterygium pinnatum).

'Ohi'a Mixed Montane Wet Shrubland occurred at the highest elevation of the section near Lihau Peak. This shrubland was wind-swept and low-statured. Common associates included pukiawe, alani, kolea, 'ohelo, stunted 'olapa, pilo, 'uki (Machaerina angustifolia), 'ama'u (Sadleria pallida) and wawae'iole (Lycopodium cernuum).

Non-native vegetation dominated 76 percent of the Panaewa section (Figure 7). Scattered throughout this alien-dominated part of Panaewa were patches of native vegetation. Degraded examples of Mamaki (Pipturus albidus) Lowland Wet Shrublands were encountered in the upper mesic and riparian habitats, such as along Kanaha Stream. Non-native plants including ti (Cordyline fruticosa), saplings of kukui (Aleurites moluccana), butterfly bush (Buddleia asiatica), strawberry guava (Psidium cattleianum) and thimbleberry (Rubus rosifolius) were common in these mamaki shrublands.





'Ohi'a Mixed Montane Wet Shrublands (previously described) were also observed scattered throughout the non-native part of Panaewa section, in patches too small to show in Figure 7. Patches of Mixed Fern/Shrub Montane Wet Cliffs were also seen during helicopter reconnaissance below 4,500 feet. This vegetation type typically formed small patches in a complex mosaic with adjacent vegetation types and were dominated by 'ape'ape (Gunnera petaloidea) and 'ama'u.

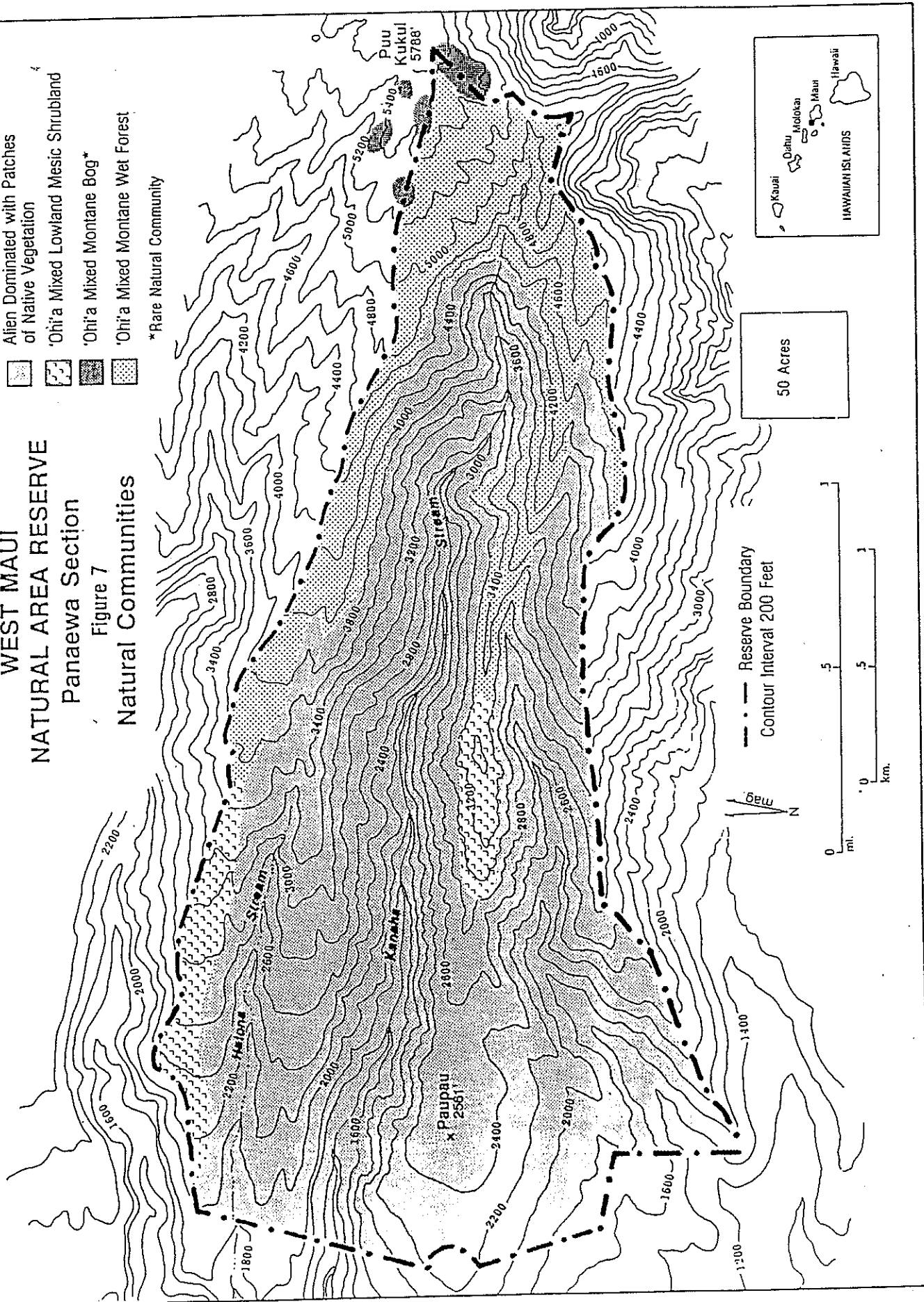
Two large patches of 'Ohi'a Mixed Lowland Mesic Shrubland, totalling about 5 percent of the Panaewa section, were encountered on two ridges below 3,600 feet. Constituents of this shrubland were the same as described for Lihau section, though in this section the shrubland occurred at lower elevations.

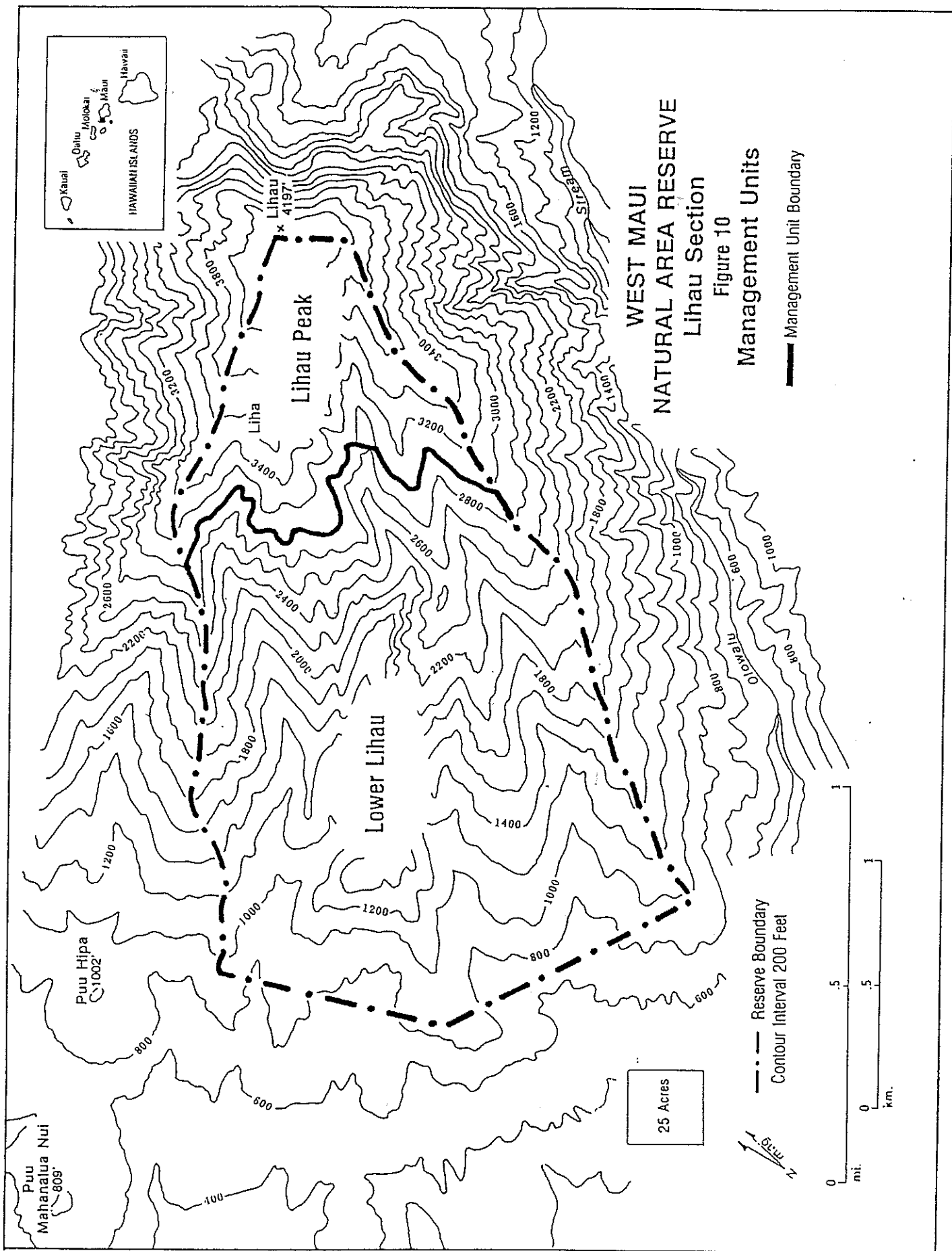
A mosaic of 'ohi'a-dominated montane wet forests occupied about 309 acres above Panaewa's alien-dominated vegetation. The mosaic was comprised of 'ohi'a/'olapa, and 'ohi'a/uluhe montane wet forests. Pristine examples of the rare 'Ohi'a Mixed Montane Bogs, were observed in the highest elevations of Panaewa section near Puu Kukui. Associated species and codominants varied considerably in the examples of this bog type seen throughout the Reserve. Small depressions were generally occupied by mixed shrubs such as pukiawe and stunted 'olapa, or the large sedge, 'uki. On more exposed flats, 'ohi'a was of much lower stature, and associates tended to be grasses and sedges such as Carex spp., Oreobolus furcatus, kuolohia (Rhynchospora chinensis ssp. spiciformis), and Deschampsia nubigena. Relatively constant associates of the 'ohi'a bogs included laukahi (Plantago pachyphylla), greensword (Argyroxiphium grayanum), and Lobelia gloria-montis.

WEST MAUI NATURAL AREA RESERVE Panaewa Section

Figure 7
Natural Communities

-  Alien Dominated with Patches of Native Vegetation
-  'Ohia Mixed Lowland Mesic Shrubland
-  'Ohia Mixed Montane Bog*
-  'Ohia Mixed Montane Wet Forest
- *Rare Natural Community





canopy and ground cover remain intact. There are several non-native weed species in the Reserve, however, which form monotypic stands and displace native vegetation over large areas. These are priority weeds for management. Weed control activities will focus on priority weeds within specific management areas, and on localized populations of priority weed species, which could spread if not controlled.

- 4) Certain upper portions of the Reserve are weed free and not yet disturbed by feral pigs. These areas represent important baseline research sites that need close monitoring to ensure they remain in as pristine condition as possible. Public access into these areas should not be encouraged and in some cases may need to be controlled. The lower elevation portions of the Reserve are important buffer zones, protecting the pristine upper portions from disturbances, such as ungulates and weeds, which could move up from below.

B. Management Unit Descriptions

The Reserve has been divided into ten management units (figures 10-13). Descriptions of each unit follow, with an outline of problems, key program features, and management priorities:

Lihau Section (Figure 10):

Lihau Peak - This remote 175-acre unit, mostly above 3,000 feet elevation, includes 'ohi'a forest and shrubland communities. It has been little impacted by pigs or weeds. This unit has highest priority for monitoring in Lihau section, to ensure it remains undisturbed. Any evidence of feral ungulates or invasion of priority weeds will necessitate immediate management attention. Access into the unit should not be encouraged.

Lower Lihau - This unit (785 acres) is an important buffer for upper forests. The native grassland and its associated Gouania hillebrandii populations need special protection from weeds, fire, and human impact. The lower elevations are extremely dry and the County dump near the lower Reserve boundary poses a fire threat. A contingency plan will be prepared to ensure a quick initial fire response.

Panaewa Section (Figure 11):

Upper Panaewa - This remote and pristine 245-acre unit, mostly above 4,600 feet elevation, includes 'ohi'a forests and some exceptional 'ohi'a montane bogs. This unit has highest priority for monitoring in the Panaewa section to ensure it stays as undisturbed as possible. Access into the area should not be encouraged. Any evidence of fresh pig sign or invasion by priority weeds will necessitate immediate management attention.

III. MANAGEMENT

A. Key Management Considerations

The overall management goal is to protect and maintain the Reserve's native character. The following key considerations were included in the management programs developed to achieve this goal:

- 1) The West Maui Reserve encompasses a very large area, much of which is inaccessible. At this time it is not economically realistic to intensively manage the entire Reserve. Management of specific areas has been prioritized based on the biological resources they contain, the extent of current disturbances, the nature of other biological threats within and near the area, and the feasibility of management (e.g. topography and access). Intensive management activity will begin in the upper elevation forests above 4,000 feet, to limit the impact of feral pigs on the Reserve's most pristine portions. These areas provide invaluable watershed forests for West Maui residents and industries. The other less pristine portions of the Reserve will not be ignored and will also receive protective management over the next six years.
- 2) Pigs constitute the most severe threat currently affecting the Reserve (Appendix 8). Their rooting and wallowing destroy native plants and disturb ground cover on the forest floor. Such damage limits effective regeneration of native plants, and creates conditions favorable for certain non-native weeds throughout the Reserve. This in turn degrades the quality and integrity of native plant communities, threatening the existence of species that rely on the forest for survival. This disturbance also threatens the quantity and quality of water originating from the forest watershed.

Control of feral pigs is the essential first step in maintenance of the Reserve's native plant communities. Aggressive control activities are critical for effective long term reduction of the pig population. (These activities are outlined in detail in the Ungulate Control Program section.) Non-native plant invasion in heavily disturbed areas is minimal at this time. Native vegetation should recover, once feral pigs are controlled. The few pristine areas left in the Reserve are all priority areas for feral pig control.

Fence locations to protect the Reserve from feral pigs should not be restricted by Reserve boundaries, but strategically placed to take advantage of the natural barriers created by West Maui's steep topography. Cooperative management agreements with adjacent private landowners will be needed. Pig control activities in the Reserve should be coordinated with Maui Land and Pineapple's pig control program. (See D., Boundary Administration and Special Uses.)

- 3) Many non-native plants observed in the Reserve are shade intolerant and pose no major problem as long as the native

Violet Lake and its aquatic larvae were seen in the lake. Crickets were heard by day and night in the montane wet forests and shrublands. Other native insects, such as leafhoppers, beetles, psocids, psyllids, and moths were also common. Native aquatic insects were seen in pools and streams. Native succinid snails were common on foliage.

Although documented collections are few, at least 30 species of native land snails are endemic to West Maui. Populations of the large, rare tree snail species, Partulina perdix, P. splendida, P. gouldii, P. tappaniana and Perdicella kuhnsi have been found within or near the Reserve boundaries between 1980-84 (Severns n.d.). All these tree snail species are endemic to West Maui, except for P. perdix, also known historically from East Maui (appendices 5 and 7).

Fauna which made up the Hawaiian Continuous Perennial Stream community in Kahakuloa Stream included large numbers of the rare 'o'opu alamo'o (Lentipes concolor), and as many as three other goby species. The stream nerite or hihiwai (Neritina granosa) was also observed. Large non-native prawns (Macrobrachium spp.) were observed in low numbers, and may represent a threat to the native fauna.

The non-native component of the invertebrate fauna was marked by incidental species, such as small syrphids. The most noticeable introduced insects were large sarcophagid flies, probably associated with feral pigs. The survey crew searched for ants in the more mesic grassland, shrubland and upper forest regions, but none were found. Yellowjackets, Vespula spp., were seen once in 'Ohi'a Mixed Shrub Montane Forest in Honokowai, and once in 'A'ali'i Mixed Lowland Dry Shrubland. Overall, introduced invertebrate species do not seem common in the Reserve and are not important management considerations at this time.

Non-native birds such as the Japanese White-eye (Zosterops japonicus) and Japanese Bush-warbler (Cettia diphone) were commonly seen and heard on all transects. A few Spotted Doves (Streptopelia chinensis) were heard in 'Ohi'a mixed montane shrublands. One small mouse (species unidentified) was seen in 'Ohi'a Mixed Montane Bog at Panaewa. Mongoose (Herpestes auropunctatus) tracks were seen on the Puu Kukui Trail (Honokowai section), and rats (Rattus spp.) were seen near the Puu Kukui rain gauge at 4,200 feet elevation. Feral ungulates are discussed in the following Key Management Consideration section, along with a summary of the threats they pose to the Reserve.

Seventeen rare plant taxa have been observed within the Kahakuloa section of the Reserve, 10 of which have been seen recently. The seven taxa not reported recently are Acaena exigua, Bidens conjuncta, Cyanea kunthiana, Geranium humile, Pelea orbicularis, P. parvifolia, and Platanthera holochila.

Of the 10 taxa reported recently from the Kahakuloa section, four taxa weren't seen during this survey: Calamagrostis expansa, C. hillebrandii, Joinvillea ascendens ssp. ascendens, and a naupaka not yet published, Scaevola hobdyi. The six taxa seen during this April survey included the largest known population in the world of Argyroxiphium caliginis (Eke silversword), consisting of thousands of plants in the bogs along transect 10, from 4,150 feet elevation to the summit. Though not in flower or fruit, many healthy seedlings and mature plants were seen. This taxon was named for its occurrence on Eke. Thousands of Isoetes hawaiiensis, an aquatic plant, were observed in the approximately one dozen montane pools on the summit of Eke. This rare taxon is known only from this location, and from montane pools in the Kohala Mountains of the Big Island. Hundreds of mature Lagenifera maviensis plants and seedlings, mostly in fruit and flower, were observed surrounding the pools at the summit of Eke and on the slopes immediately below Eke on transect 10. This taxon was also seen in the Honokowai section.

A new population of the rare Myrsine vaccinioides (shrubs 2-3 feet tall) was found in the more moderately sloped bogs directly below Eke summit on transect 10. Hundreds of healthy Wikstroemia bicornuta, both seedlings and mature plants in flower and fruit, were observed in the bogs along much of transect 10. This taxon was not seen in the bogs of any other section of the Reserve, and is known from only Eke and a few restricted areas on Lanai. One Hibiscus kokio ssp. kokio tree was seen along Kahakuloa Stream.

Non-native plants that affect the Reserve are discussed in under management programs in section III.

C. Fauna

Though West Maui's forests are for the most part intact, native bird species diversity is unexpectedly low. Reasons for this may include West Maui's relatively small and isolated area, competition from non-native birds or mosquito-transmitted disease. The native honeycreeper 'Apapane (Himatione sanguinea sanguinea) was fairly common throughout all sections, but only one 'I'iwi (Vestiaria coccinea) was seen in 'Ohi'a/'Olapa Montane Wet Forest in the Panaewa section. One 'Amakihi (Hemignathus virens wilsoni) was seen in the 'Ohi'a Mixed Shrub Montane Wet Forest at Puu Kukui summit (Honokowai section). A migratory shorebird, Koea (Pluvialis dominica), was seen and heard in the 'Ohi'a Mixed Montane Bogs of Honokowai and Panaewa sections. A list of bird species known from the area is in Appendix 6.

In all of the natural communities visited, native invertebrates, such as spiders, wasps and flies were noticeable. The native pinao dragonfly (Anax strenuus) was seen flying near

Of the 17 taxa reported from the Panaewa section, six have been reported recently (within the last 15 years). Eleven taxa were reported prior to 1972: Achyranthes splendens var. splendens, Cyanea kunthiana and C. obtusa, Diellia erecta, Exocarpus gaudichaudii, Gouania vitifolia, Lipochaeta lobata var. lobata, Lobelia hypoleuca, Plantago princeps var. laxiflora, Remya mauiensis, and Sicyos cumerinus.

Five of the six recently reported rare taxa were observed during the field survey. (Acacia koaia was last observed in the Panaewa section in 1980.) Eurya sandwicensis was seen on transects 5 and 6, on the ridges extending south and west from Puu Kukui. Geranium humile plants were observed in the small bogs along transect 6. Lagenifera maviensis was also observed in bogs, along the ridge between Puu Kukui and the peak to the south. A new population of Myrsine vaccinioides was discovered in the bog on transect 6. Sanicula purpurea plants were also observed in the bog.

Nine rare taxa have been reported recently (since 1972) within the boundaries of the Honokowai section; another 10 taxa were reported from the section prior to 1972 (Appendix 5). A listing of those taxa not recently observed in the section follows: Calamagrostis expansa, C. hillebrandii, Cyanea kunthiana, Diellia erecta, Doodia lyonii, Joinvillea ascendens ssp. ascendens, Pelea orbicularis and P. parvifolia, Phyllostegia bracteata, and Platanthera holochila.

Three of the nine taxa seen since 1972 were not seen during this survey for Honokowai section: Asplenium schizophyllum, Clermontia oblongifolia var. mauiensis, and Cyanea scabra. Six taxa were seen during this April 1988 survey. Eurya sandwicensis was observed on transect 8 on steep slopes, as well as in the Panaewa section. Two small populations of Argyroxiphium caliginis were also observed at the same location as Eurya sandwicensis. This taxon is known only from West Maui, and there only from bogs on the slopes of Puu Kukui, and in Eke Crater. Flowering Geranium humile plants, 6-12 inches tall, were observed in Silversword Bog below Violet Lake, and scattered throughout the bogs below the summit rain gauge all along transect 8. It is known only from West Maui, and has been reported in all four sections of the Reserve.

Lagenifera maviensis was observed along transects 7 and 8, in Silversword Bog, and in the summit bogs. Hundreds of this small, rare plant were seen in flower in the bogs of the Honokowai section, as well as in Panaewa and Kahakuloa bogs. Myrsine vaccinioides was observed in the bogs and bog margins of Silversword Bog, and along transect 8 to the summit. This taxon has only recently been discovered at Violet Lake, and observations during this survey confirmed a larger range than formerly known, including the entire summit bog area of Puu Kukui, as well as bogs in the Panaewa and Kahakuloa sections of the Reserve. Three healthy populations of Sanicula purpurea were observed in Silversword Bog. This taxon is known only from Oahu and West Maui. It was also observed in the Panaewa section of the Reserve.

A total of 77 taxa of rare plants have been reported from the West Maui Reserve area. For the purposes of this plan, a species is considered rare if it is known from 20 or fewer locations worldwide, or less than 3,000 individuals. Forty-six of these taxa have been confirmed within the Reserve boundaries, and 16 were observed during the field survey. Further surveys may confirm many of the 31 other rare taxa in the Reserve. As a result of changes in plant taxonomy, some taxa currently listed by the U.S. Fish and Wildlife Service as candidate species in the 1985 Federal Register may no longer be considered rare by the Hawaii Heritage Program, and their federal status is being reevaluated (Herbst pers. com.). Because many native plants lack unique Hawaiian or common names, scientific names are used throughout this section. Hawaiian names, where available, are provided in Appendix 3.

A complete listing of current and historic (prior to 1972) observations in the Reserve is in Appendix 3, a comprehensive vascular plant species list (native and introduced) is in Appendix 4, and location maps of rare plants and animals recently reported are shown in Appendix 5.

Eight of the 14 rare plant taxa reported from Lihau section recently (within the past 15 years) were observed during this survey. The six taxa not seen during this survey were Chamaesyce celastroides var. laehiensis, Ctenitis crinalis, Hibiscus brackenridgei ssp. brackenridgei, Lysimachia lydgatei, Trisetum inaequale, and the federally listed endangered Santalum freycinetianum var. lanaiensis, which was last seen in 1987 (Appendix 3).

Achyranthes splendens var. splendens was observed during this survey in the Lihau section, in a deep gulch off transect 4. Three small shrubs of Geranium humile were observed on transect 1. Hundreds of the federally listed endangered Gouania hillebrandii plants were observed below the end of transect 4 in the Lihau section. Many juveniles were present, indicating the population is reproducing well. Though historically collected on Molokai, Lanai and Kahoolawe, the only two currently known populations are both located in West Maui; one in Lihau, the other below the lower boundary of the Panaewa section of the Reserve.

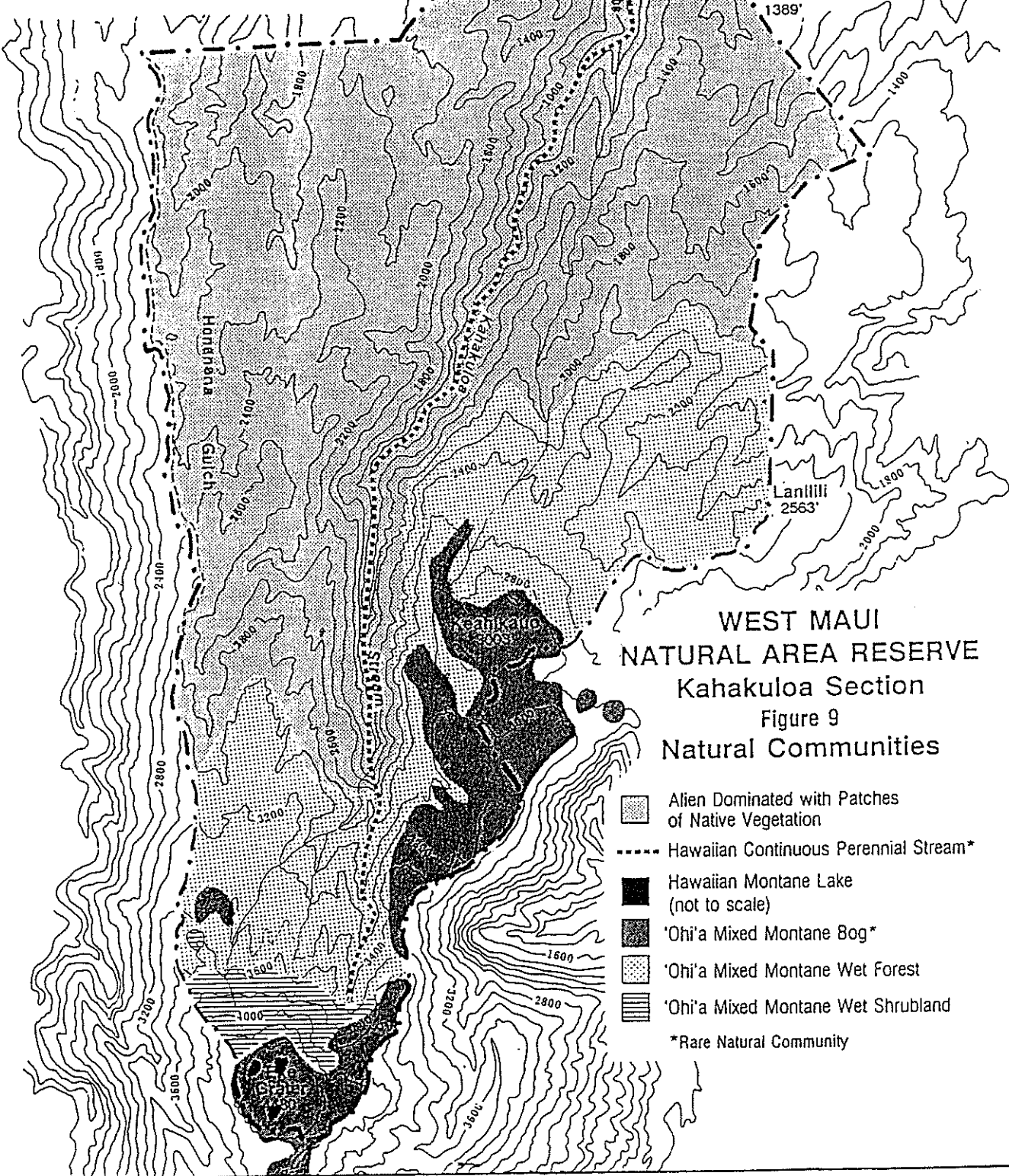
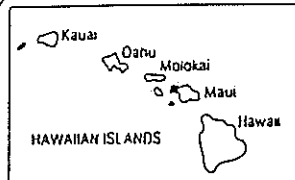
Two Huperzia mannii plants were seen growing on an 'ohi'a branch near transect 3. A large, scattered population of Lipochaeta lobata var. lobata was observed between 1,860 and 2,800 feet on transect 4. Although this taxon is typically found in dry coastal habitats, a flowering shrub was observed in dry 'a'ali'i shrubland with a non-native grass understory. Phyllostegia stachyoides was observed on transect 4, near the summit of Lihau. A scattered population of 50-100 plants of Schiedea menziesii was observed on a ridge crest below 2,800 feet. Spermolepis hawaiiensis was observed below the end of transect 4, at the base of a narrow saddle along the ridge trail. This population, only the second known of this taxon still in existence, was made up of seedlings and mature flowering and fruiting plants.

--- Reserve Boundary
 Eke Trail
 Contour Interval 200 Feet

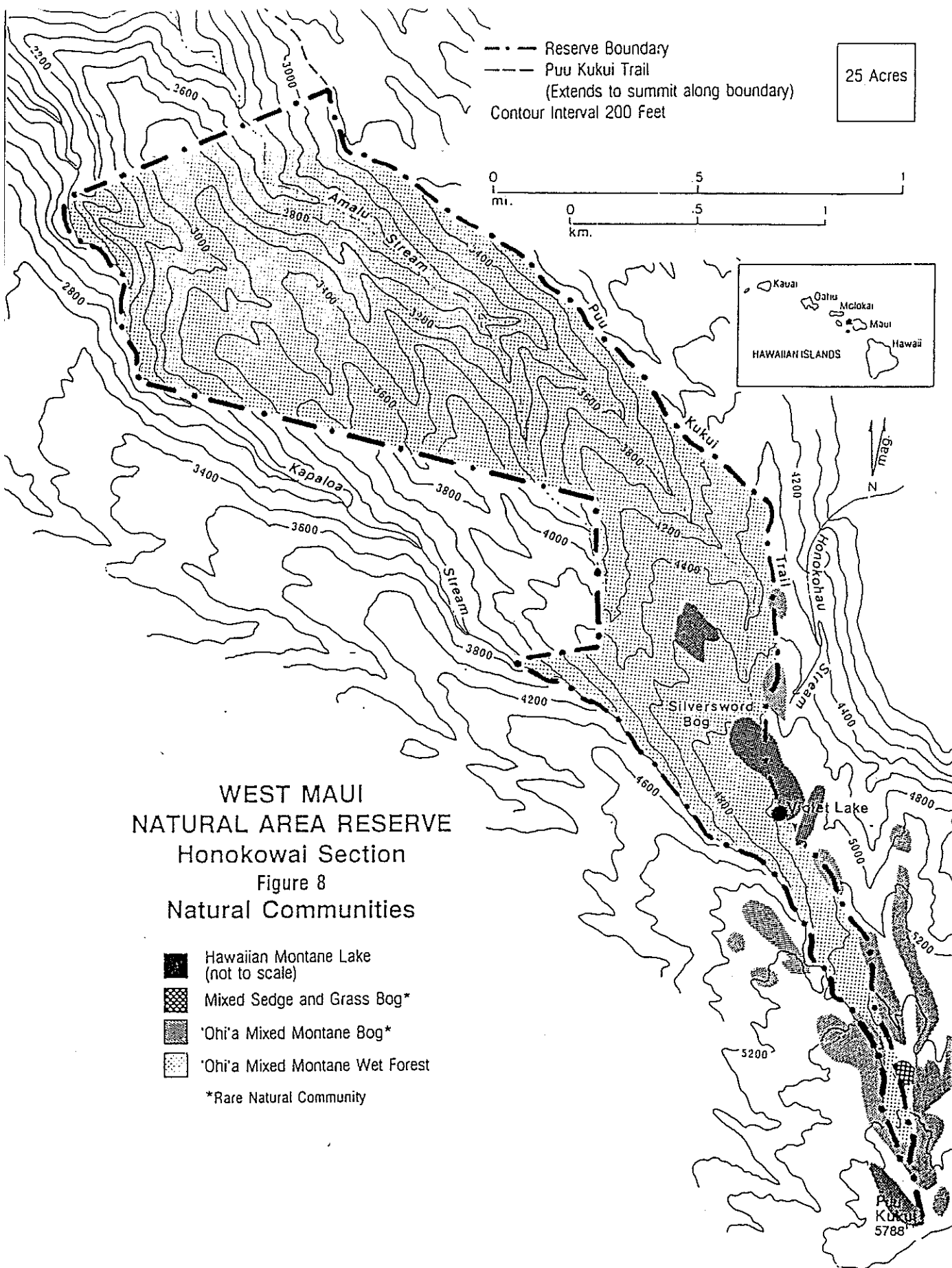
50
Acres

0 .5
mi. 0 .5
km.

N
mag



- Alien Dominated with Patches of Native Vegetation
- Hawaiian Continuous Perennial Stream*
- Hawaiian Montane Lake (not to scale)
- 'Ohi'a Mixed Montane Bog*
- 'Ohi'a Mixed Montane Wet Forest
- 'Ohi'a Mixed Montane Wet Shrubland
- *Rare Natural Community



From the lowest elevation of Honokowai section (about 2,200 feet) to the upper elevations at Puu Kukui, vegetation was dominated by a mixture of 'ohi'a montane wet forest types, with scattered patches of other vegetation (Figure 8). Mixed Fern/Shrub Montane Wet Cliffs were seen during helicopter reconnaissance below 4,500 feet. Large patches of 'Ohi'a Mixed Montane Wet Shrubland occurred below 5,000 feet, scattered throughout the 'ohi'a/'olapa, 'ohi'a/uluhe, and 'ohi'a mixed shrub montane wet forests. Examples of the rare 'Ohi'a Mixed Montane Bogs were observed starting at about 4,400 feet elevation, and continued along the section's boundaries up to the summit of Puu Kukui.

Violet Lake represents a little-known ecosystem found only on Maui and Hawaii. This example of a Hawaiian Montane Lake was approximately 10 by 20 feet in size (Figure 8). To date, constituents of this ecosystem have not been extensively studied. The Mixed Sedge and Grass Montane Bogs, which occurred on flat-topped ridges near the summit of Puu Kukui, constitute another rare bog community in the Honokowai section. The low-statured (less than 12 inches in height) sedge and grass bog was dominated by Deschampsia nubigena, Carex montis-eeka, and kuolohia. Oreobolus furcatus was common in some spots, as was laukahi. A variety of ground bryophytes and lichens were well-represented.

In the Kahakuloa section, scattered patches of native vegetation were observed among the mostly non-native vegetation in the lower elevations (Figure 9). (This non-native portion formed 65 percent of Kahakuloa section.) Degraded mamaki shrublands were seen along Kahakuloa Stream, which bisects the section. Mixed Fern/Shrub Montane Wet Cliffs were seen during helicopter reconnaissance below 4,500 feet.

Kahakuloa Stream is an example of Hawaiian Continuous Perennial Streams, another rare community type. This community is defined by continuous (completely unmodified from head to mouth) and perennial (year-long) flow, characterized by native aquatic biota. Kahakuloa Stream has the best example of native stream animals in the Reserve (see section C., Fauna).

Approximately 852 acres (26 percent) of Kahakuloa section were dominated by a variety of 'ohi'a montane wet forests. 'Ohi'a Mixed Shrub Montane Wet Forest, 'Ohi'a/Olapa Montane Wet Forest, and 'Ohi'a/Uluhe Montane Wet Forest formed this mosaic. The rare 'Ohi'a Mixed Montane Bogs began at about 2,600 feet on the section's east side, stretching up the boundary and forming the predominant natural community in Eke Crater. Scattered examples of Hawaiian Montane Lakes also occupied Eke Crater. A band between 3,600 and 4,400 feet elevations was occupied by 'Ohi'a Mixed Montane Wet Shrubland, forming about 2 percent of the section's vegetation.

WEST MAUI
NATURAL AREA RESERVE

Panaewa Section

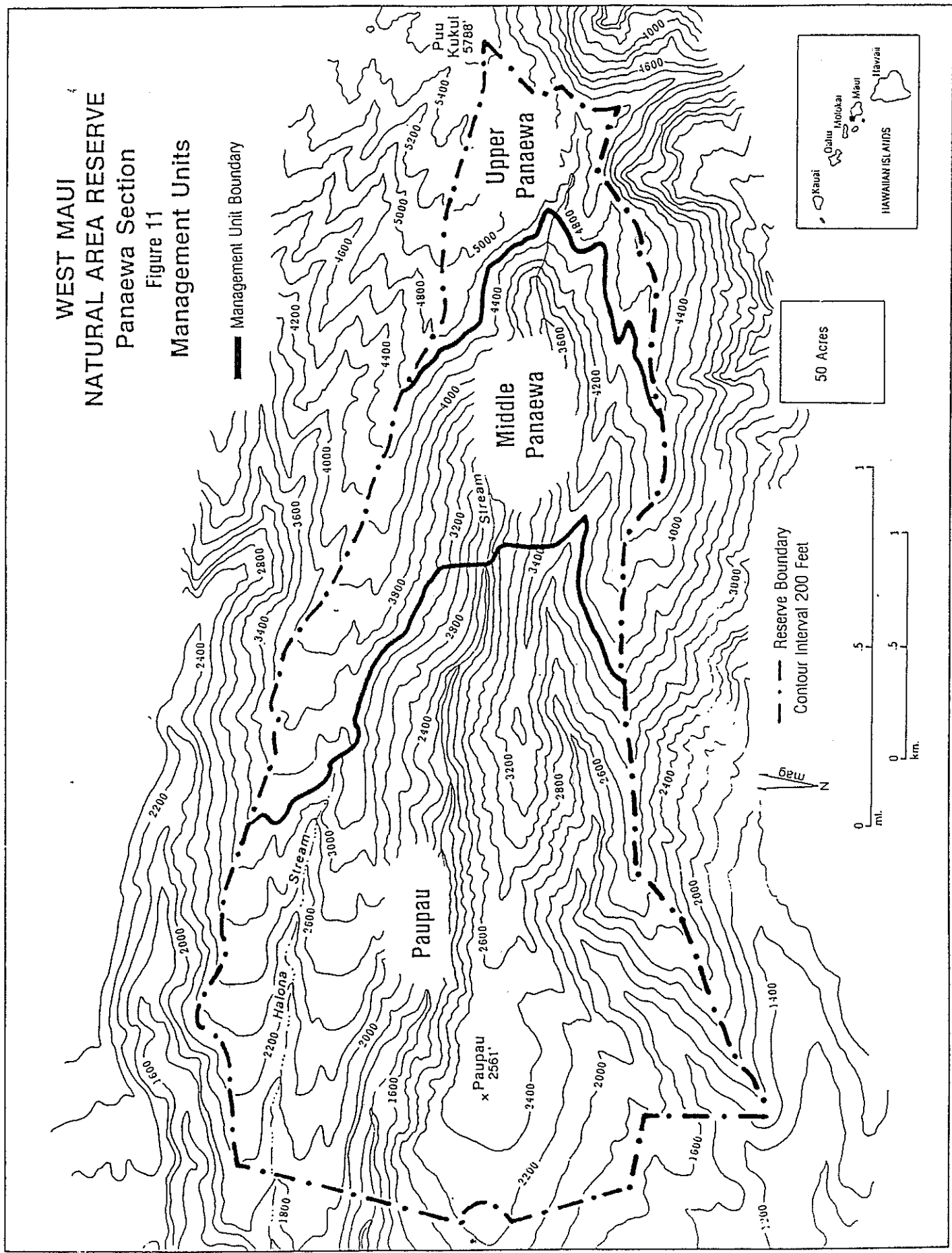
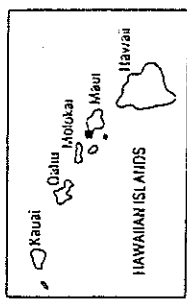
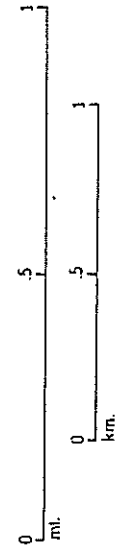
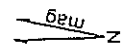
Figure 11

Management Units

— Management Unit Boundary

50 Acres

--- Reserve Boundary
Contour Interval 200 Feet



~ Middle Panaewa - This unit (515 acres), mostly above 3,000 feet in elevation, includes intact 'ohi'a montane forest along the upper ridges, but is dominated by non-native plants with patches of native vegetation. This unit is an important buffer for the pristine upper unit, and has high priority for monitoring of potential weed and feral animal threats. Strategic fencing along ridges to block pig access may be necessary.

Paupau - This lower elevation unit (957 acres) is largely dominated by non-native plants. Kanaha Stream is used as a water source for Pioneer Mill. Paupau Peak is an easy and popular hike. Signs informing the area's users of the Natural Area Reserve will be posted.

Honokowai Section (Figure 12):

Puu Kukui - This 255-acre unit, mostly above 4,600 feet, contains rare plants and two rare native bog communities. The Puu Kukui summit and Violet Lake areas, along with Eke Crater in the Kahakuloa section, are the highest priority management areas for protection from feral pigs and non-native weeds. Maui Land and Pineapple has already initiated a pig control program on adjoining lands and controls public access into unit.

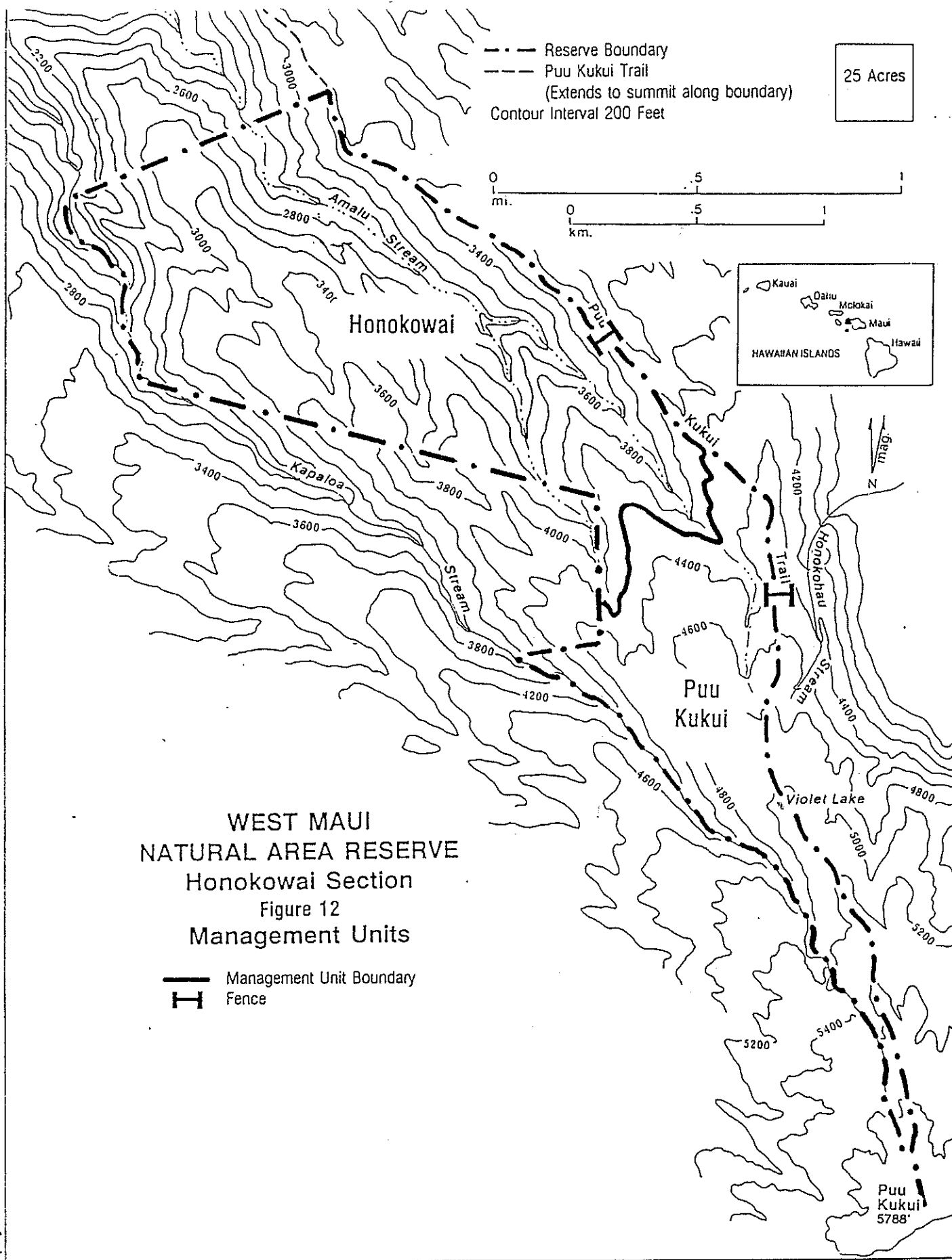
Honokowai - The unit (495 acres) contains excellent native 'ohi'a forests and is an important buffer for upper pristine sections. Aggressive pig control by Maui Land and Pineapple is already underway in adjacent private lands. High priority for feral pig control.

Kahakuloa Section (Figure 13):

Eke Crater - This 120-acre unit, above 3,800 feet elevation, contains unique native flora such as Eke silversword and Isoetes, and undisturbed bogs and pools. Few people have ever hiked to the summit of Eke Crater and the trails are poorly defined. Pig control fences have been built by NARS staff and volunteers to protect Eke Crater, but feral pigs are still in the lower portions of the unit. This unit is one of the Reserve's most important and unique areas and has highest priority for feral animal control and weed control.

Keahikauo - This 450-acre unit above 2,800 feet elevation contains extensive bogs and 'ohi'a forests, and includes the headwaters of Kahakuloa Stream. Feral pig activity is high. The management priority for this unit entails additional survey work to determine special areas that need protection and effective strategies to control feral pigs.

Kahakuloa - This is a large (2,705 acres) unit containing patches of native forest vegetation within areas dominated by non-native vegetation. The undiverted Kahakuloa Stream supports healthy populations of native stream animals. The

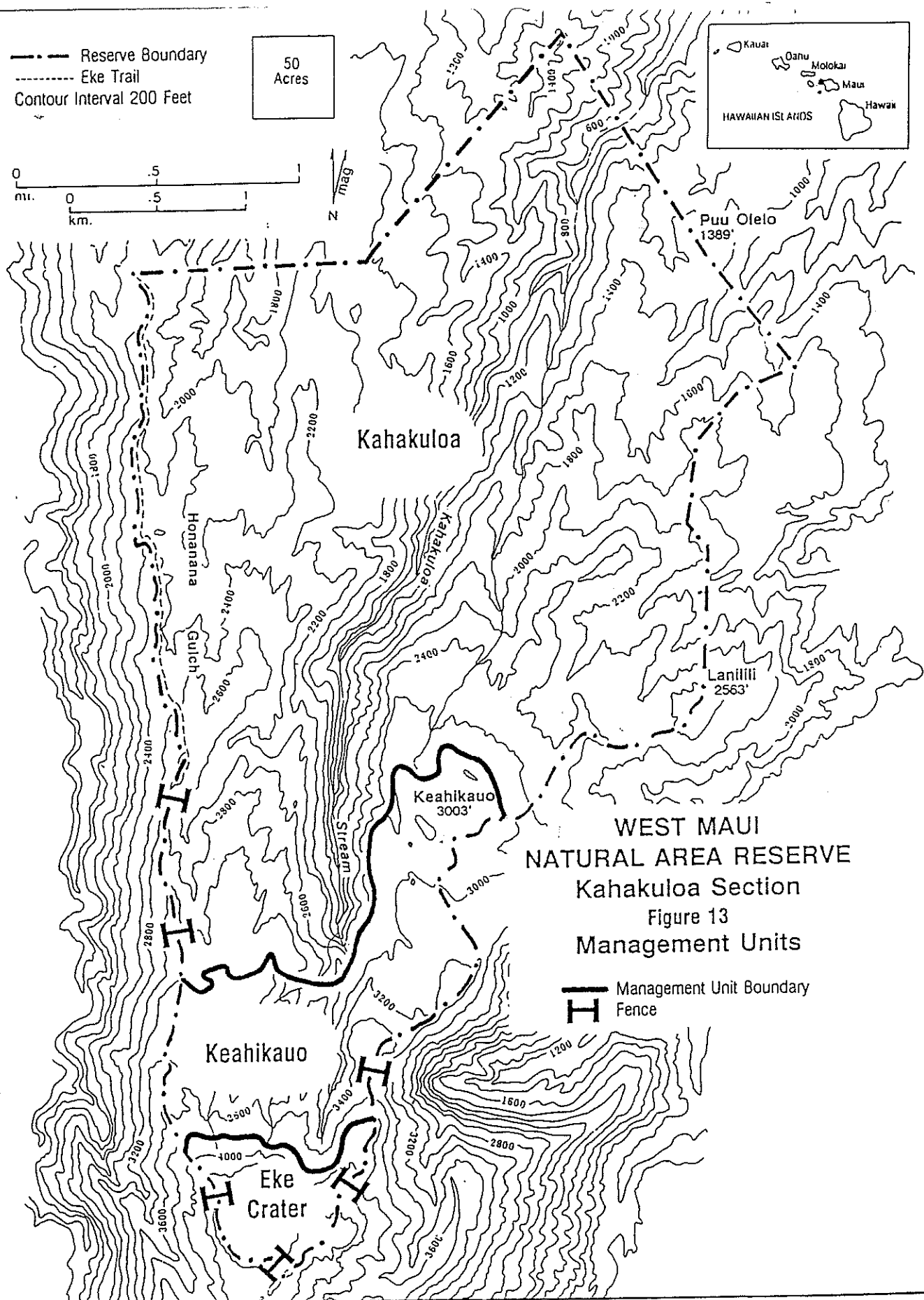
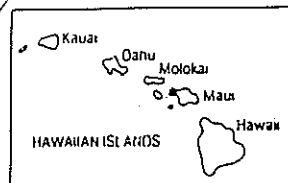


--- Reserve Boundary
 - - - Eke Trail
 Contour Interval 200 Feet

50
Acres

0 .5 1
mi. 0 .5 1
km.

N
mag



WEST MAUI
 NATURAL AREA RESERVE
 Kahakuloa Section
 Figure 13
 Management Units

Management Unit Boundary
 Fence

unit provides important watershed cover for the stream. Monitoring is a high priority, especially to learn more about threats to the endemic fauna in Kahakuloa Stream. Public hunting pressure needs to be increased and negotiations are underway to improve access.

C. Management Programs

The following four management programs outline the long-term goals for the Reserve. A six-year implementation schedule is proposed. Although the programs are listed by priority, they fit together to form an integrated management package.

Priority #1 - Ungulate Control Program (WMA-RM-01)

GOAL: Eliminate ungulates in select areas of high biologic value. In the rest of the Reserve, reduce the impact of ungulates to a level that prevents further degradation of the Reserve and allows the greatest possible recovery of the Reserve's native species.

Statement of the Problem: Feral ungulate control is critical to the survival of native ecosystems in the Reserve. There are many techniques for feral ungulate control. The NARS manager will need the flexibility to use all the tools available as the West Maui Reserve presents different vegetation types, access problems, and resource protection priorities. These tools include public hunting, fencing, staff hunting, and snaring.

West Maui's steep topography presents an opportunity for an effective pig control program. Access to key upper areas of the Reserve, many of which are pig-free, are along knife-edged ridge trails. Short fences along select ridges have effectively stopped pig movements into some of these areas. Helicopter use is essential to manage these remote areas. This will only be possible during good weather, which is the exception, as wet, windy conditions normally prevail.

During this survey, no recent evidence of pigs, goats, or any other ungulates were encountered in the upper parts of the Lihau and Panaewa sections (Appendix 8). The wet upper and middle elevation forests and shrublands were pristine with many epiphytes and rich understory plants. Fresh pig activity was seen during the survey in the Honokowai section. Pigs seem to move in from adjacent Honokahua and Honolua gulches and have caused heavy damage. Fresh pig damage was evident near 4,500 feet elevation on the Puu Kukui trail, despite hunting pressure by Maui Land and Pineapple and their two recently constructed pig fences in Honokowai (Figure 12).

Pig damage was also observed during the survey in the Kahakuloa Section. The Keahikauo unit had moderate to heavy damage with digging, trails, and fresh scat seen. The lower slopes of the Eke Crater unit also showed evidence of moderate to heavy pig damage. Six recently constructed fences by NARS have successfully protected Eke Crater and have limited further ingress of pigs into

the unit (Figure 13). Pig tracks and trails were seen right up to the fences but no fresh digging or pig sign was seen in Eke Crater itself.

Fence construction, pig removal, and fence maintenance are all essential and integral components of a successful ungulate control program. Attempts to reduce pig populations to remnant levels in similar terrain without fences have not been effective as animals can move into areas where population densities were reduced. Funds spent on feral pig control will be ineffective unless population size can be reduced to low levels and not allowed to build back up.

Alternative Actions and Probable Impacts:

1) No action. Accept the continuing deterioration of West Maui's forest watershed and native resources. Without control, pigs degrade native communities, lowering biological diversity and increasing non-native plant invasion.

2) Attempt control of feral animals using only public hunting. Do not attempt to use fences, staff hunting, or snaring within the Reserve. Impacts of feral pigs under this alternative will probably be roughly the same as alternative #1, except for small portions of the Reserve where increased hunting activity may keep pig population down and protect small areas of forest. Pig removal will be less effective without fences to keep new populations from moving into the Reserve.

3) Control feral pigs with the aid of fences. This method has proven successful and beneficial for the preservation of native ecosystems. Recovery of native vegetation has occurred in similar areas where management programs have been implemented. The advance of non-native weed species encouraged by pig disturbance can also be slowed. Native plant species surviving only as epiphytes because of pig disturbance can become re-established on the forest floor.

Recommended Action: Alternative #3 is recommended, and involves three projects: fence construction, fence maintenance, and pig removal. Better access for public hunting is planned for the Kahakuloa unit.

Project 1 - Fence Construction

Additional fences will be constructed along strategic ridges to block pig access into the upper pristine management units in the Reserve. The fences will also create smaller areas to expedite pig removal. Aggressive pig removal is essential in conjunction with the fencing project to take advantage of induced pig movements and to avoid restriction of pigs in one location causing heavy localized damage.

The existing fences are short (less than 50 yards) and impassable as they straddle narrow ridges. One-way gates have been constructed into four fences which are intended to allow pigs to

move out of priority management areas, but not back in. Six new fences are budgeted to add to the existing six NARS fences and two Maui Land and Pineapple fences already constructed. Monitoring data and the pigs' response to existing fences and removal activities will determine the best final locations for these new fences.

Cost/Workload: The following resources will be needed to construct fences:

Year 1	(two fences)	Total	\$ 8,550
Year 2	(one fence)	Total	\$ 4,300
Year 3-6	(one fence)	Total	\$ 4,300/year

Costs are based on three helicopter round-trips per fence (scouting, materials transport, construction) at \$550 per hour. Personnel costs are based on eight person days (PD) per fence at \$85 a day for a Reserve manager and \$70 a day for technicians. Materials are \$2,000 per fence, which includes a one-way gate. Volunteer labor will help in fence construction (See Priority #4, Public Education and Volunteer Program). Strict procedures for clearing fence routes will be established to minimize disturbance to vegetation, ground cover, and introduction of weeds. A botanist will search planned fence locations for rare plants and notify crew clearing the fence line.

Project 2 - Fence Maintenance

Ideally, fences would be inspected and maintained monthly. However, the remoteness and inclement weather of the upper Reserve area makes this impractical and maintenance is planned quarterly. Inspections will be done in conjunction with other resource management activities such as pig removal, monitoring, and non-native plant control.

Cost/Workload: The following annual workload is projected for quarterly fence inspection:

Year 1 -	4 fences	Total	\$ 5,300
Year 2 -	8 fences	Total	\$10,600
Year 3 -	10 fences	Total	\$13,250
Year 4-6	12 fences	Total	\$15,900/year

Costs are based on a two-person crew able to inspect and repair two fences a day. One hour of helicopter time will be required for each fence at \$550 per hour. Supplies are \$300 per fence per year. Technician salary is \$70 a day.

Project 3 - Pig Removal

This project will initiate a pig removal program instituting hunting from aircraft in the upper Reserve, snaring and staff hunting in the middle portions of the Reserve, and public hunting in the lower portions of the Reserve. The goal is to reduce and maintain pig populations at remnant levels in 1,245 acres of the Reserve. Data on health, sex, and age of pigs captured during

control activities will be compiled to provide important data on program effectiveness.

Areas which will be hunted from aircraft are remote, have low pig populations, and low-stature vegetation which allow good visibility and use of infrared technology. The infrared spotter is heat sensitive and is used in the early morning before the sun has heated up the surrounding lands. The warmth of the pig's body shows up on the screen and the aircraft can move directly to its location and make visual contact. Such areas within the Reserve include the Eke Crater, Puu Kukui, Lihau Peak and Upper Panaewa units. Hunting from aircraft minimizes damage to wet, boggy areas by avoiding trampling of vegetation and reduces the accidental introduction of weed seeds.

Snaring is most effective in areas with a combination of well-utilized pig trails, topographic features that will channel movements, and trees to anchor the snares. Areas where snares are set will be posted to restrict public access. The most effective approach is to set snares and leave the area unattended to minimize the effect of human presence, returning later to assess the success and condition of the snares. Fences will restrict pig movement in the Reserve and create good snaring opportunities along fence lines. Snares in rain forests last six months to a year. Recommended units for snaring include near fences in the upper Reserve, Keahikauo unit, and portions of the Honokowai unit to complement Maui Land and Pineapple's pig removal program.

Improved public access will increase hunting pressure in the lower Kahakuloa unit, which comprises 40 percent of the Reserve. At this time, public access into the Honokowai section is controlled and restricted by Maui Land and Pineapple. Reserve management staff will coordinate with Maui Land and Pineapple to insure complementary pig control activities. Public access into this section is not recommended at this time.

Cost/Workload: The following resources will be needed to conduct the pig removal project:

Year 1-2	Aircraft hunting (20 hours at \$750/hr.)	\$15,000
	Personnel (43 PD)	3,350
	Helicopter transport (6 hours at \$550/hr.)	3,300
	Supplies and Support	<u>1,500</u>
	Total	\$23,150/year
Year 3-4	Helicopter hunting (15 hours at \$750/hr.)	\$11,250
	Personnel (39 PD)	3,050
	Helicopter transport (6 hours at \$550/hr.)	3,300
	Supplies and Support	<u>1,500</u>
	Total	\$19,100/year
Year 4-5	Helicopter hunting (10 hours at \$750/hr.)	\$ 7,500
	Personnel (36 PD)	2,800
	Helicopter transport (6 hours at \$550/hr.)	3,300
	Supplies and Support	<u>1,500</u>
	Total	\$15,100/year

Costs are based on a two-person crew able to establish 50 snares per day or check 250 snares per day. Snares (\$6 each) will be replaced every year and inspected five times a year. Snaring densities will be approximately 100 snares for every 250 acres within the management units. Costs for helicopter with infrared spotting equipment is \$750 per hour. Helicopter costs for crew transport is \$550 per hour (one round trip); salaries are \$85 per day for a Reserve manager and \$70 per day for technicians. There will be 1.5 PD (3 people for one-half day) for helicopter hunting trips.

Priority #2 - Monitoring Program (WMA-RM-02)

GOAL: Monitor the effectiveness of management projects and track significant ecological changes through long-term scientific monitoring.

Statement of the Problem: Management activities may not always achieve desirable results and management efficiency needs to be judged. Monitoring changes in non-native and native plant distribution, and animal species abundance entails recording specific data at permanent points and transects in the Reserve. Monitoring also documents progress and facilitates refinement of management techniques employed in the Reserve.

Alternative Actions and Probable Impacts:

- 1) No monitoring program. This could lead to inefficient management resulting from poor understanding of the area's biological needs.
- 2) Conduct ad hoc monitoring whenever possible. This is likely to be considerably less effective in the long run than a systematic approach.
- 3) Establish systematic monitoring programs for ungulate damage, non-native weed invasion, native vegetation recovery, and status of rare species. Increase monitoring intensity for select problems and areas as needed.

Recommended Action: Alternative #3. Develop monitoring programs to evaluate effects of management activities and identify future management needs. Most transects will require a two-person crew for safety. Two-person monitoring crews will be dropped off by helicopter at upper elevations, take data at established monitoring points, and hike out. Specific goals of the program are to determine; 1) the effectiveness of staff pig removal and public hunting in reducing ungulate damage, 2) the success of priority weed species control, 3) the location of incipient populations of other priority weeds, and 4) status of known rare species. Some monitoring activities will be done in conjunction with fence inspection.

Two important biologic resources in the Reserve will need special monitoring; the endangered Gouania hillebrandi population

in the Lihau section and Kahakuloa and Makamakaole Streams in the Kahakuloa Section. Although the G. hillebrandi population is healthy and thriving with no apparent threats at the moment, monitoring is needed for Pinnaspis strachani, a scale which has infested the other known G. hillebrandi population on West Maui, invasion by non-native weeds, and feral ungulates. Although not funded for in this plan, additional research on the reproductive biology and pollination ecology of G. Hillebrandi is needed.

Maintaining the present physical and chemical quality of Kahakuloa and Makamakaole streams within and outside the Reserve is a pivotal factor affecting the ecology of the native stream animals (see D. Boundary Administration and Special Uses). If an agency pursues export of water from these streams outside of the Reserve, a special stream monitoring program will be needed to evaluate affects of changing stream flow regimes. This is not budgeted for in this plan. Monitoring of these streams is planned to prevent the introduction and establishment of non-native aquatic and terrestrial species and evaluate current consumptive uses.

Another objective, which is outside the management scope of this plan, should be to promote and facilitate scientific research in these stream communities which addresses aspects of limnology and population biology of native fauna. It may be appropriate to develop data on stream flows, habitat availability, and population status to serve as a baseline against which future threats can be evaluated.

Cost/Workload: The following resources will be needed to conduct the monitoring project:

Year 1	Personnel (80 PD)	\$ 6,200
	Helicopter (12 trips and reconnaissance)	3,300
	Supplies	<u>1,500</u>
	Total	\$11,000/year
<u>Year 2-6</u>	<u>Same as year 1</u>	<u>Total \$11,000/year</u>

Costs are based on 10 monitoring trips. Helicopter cost is \$550 per hour. Salaries are \$85 per day for Reserve manager and \$70 per day for a technician.

Priority #3 - Non-Native Plant Control Program (WMA-RM-03)

GOAL: To limit the spread and, where possible, eradicate non-native plant species which are already or may become invasive weeds in the Reserve.

Statement of the Problem: Many non-native plants have become established in Hawaii and their total removal from the Reserve is not feasible. The best control strategy is maintenance of intact native forests through limitation of disturbance. While feral pig control will help, it is not completely effective in limiting weed spread, as many weeds are spread by birds and people.

Control of priority weed species in key management units will be necessary. Manual and chemical weed control is costly and use should be prioritized by the nature of the weed, the value of the area it is invading, and the effectiveness of the control measure. Biocontrol is an important potential tool in the management of wide spread priority weed species and the NARS should support interagency biocontrol projects.

The upper elevations of the Lihau Reserve were almost weed-free. The non-native species found included Maui pamakani (Ageratina adenophora), thimbleberry (Rubus rosifolius), and butterfly bush (Buddleia asiatica), none of which are considered priority weeds at this time. In the middle and lower elevations more weed species were observed, especially in gulch bottoms and slopes. The most widespread included broomsedge (Andropogon virginicus), koa haole (Leucaena leucocephala), prickly pear cactus (Opuntia ficus-indica), natal red top (Rhynchelytrum repens), and kiawe (Prosopis pallida).

Much of the upper elevation areas of Panaewa were pristine and weed-free. An incipient population of Tibouchina herbacea was discovered. This is a priority weed species, as other members of this genus have become major threats throughout the State. Weeds found in Panaewa's lower elevations were along the Kanaha Stream and at Paupau, especially guava (Psidium guajava), Maui pamakani, lantana (Lantana camara), Christmasberry (Schinus terebinthifolius), silk oak (Grevillea robusta), and Passiflora suberosa, and their potential spread into upper forest areas needs to be controlled.

Human traffic on the Puu Kukui trail is a major source of weeds in the Honokowai section. During the survey, blackberry (Rubus argutus), Maui pamakani, Tibouchina herbacea, fireweed (Erechtites valerianifolia), bog rush (Juncus effusus), Juncus planifolius, Hypochoeris radicata, and a few thimbleberry plants were found along the trail. Most areas off the trail were weed-free. Blackberry and Tibouchina herbacea are considered priority weeds.

The top of Eke Crater was pristine and virtually weed free. Non-native plant species found on the slopes below Eke Crater included broomsedge, Paspalum conjugatum, Tibouchina herbacea, Paspalum urvillei, thimbleberry, Sacciolepis indica, butterfly bush, and Maui pamakani. Weeds found in the lower elevations in Kahakuloa Stream were guava, thimbleberry, butterfly bush, ginger (Hedychium spp.), mango (Mangifera indica), Christmasberry, and lantana.

Alternative Actions and Probable Impacts:

1. Control pigs, but do not attempt to control any priority non-native plant species. This will reduce the spread of many pig-dispersed plant species, but will allow continued advance of plants spread by birds and people. Decreased rooting and disturbance to the forest floor by feral pigs will slow down establishment of many non-native plants, but already established plants may continue to

spread unchecked. A few especially aggressive weeds could overwhelm large areas.

2. Control priority non-native weed species in the key management areas before they become widely established. Set up monitoring transects to locate other incipient populations of priority weed species. Management measures would include selective use of herbicide and manual removal with hand tools.

3. Control all non-native plant species in the Reserve. This alternative would require substantial resources and is not practical.

Recommended Action: Alternative 2 is recommended. Remove blackberry (Rubus argutus) from Puu Kukui Trail. Tibouchina herbacea should be removed where found. Non-native plant removal along trails and fences should occur as part of periodic maintenance. Establish monitoring transects for other priority weeds.

Detailed records of the effectiveness of control methods used in the Reserve will be kept. Coordination between NARS and other involved agencies in plant control work will reduce management costs. Strict precautions will be taken to ensure management personnel do not transport weed seeds into the Reserve on their shoes or equipment (including helicopters). Hikers and hunters will be informed of this threat by posted signs along access trails into the Reserve.

Cost/Workload:

Year 1 - Personnel (40 PD)	\$ 3,100
Helicopter (8 trips)	4,400
Supplies and support	<u>\$ 1,000</u>
Total	\$ 8,500
Year 2-6 same as Year 1	Total \$ 8,500/year

Costs are based on helicopter at \$550 per hour (one round trip), salaries are \$85 a day for Reserve manager and \$70 a day for technicians.

Priority #4 - Public Education and Volunteer Program (WMA-RM-04)

GOAL: To build public understanding and support for the Reserve and the NARS in the local community. Educational opportunities will be provided for interested groups. Volunteer labor to help staff in management activities will be procured.

Statement of the Problem: Most residents and visitors are unaware of Hawaii's natural heritage. Even fewer realize that native resources and the benefits they provide are being threatened. Management of this Reserve will be a long-term effort, and public support is essential.

The pristine upper portions of the Reserve are invaluable for baseline research as examples of undisturbed Hawaiian ecosystems. Public use of these areas should not be encouraged and in certain areas must be controlled. The general public, however, needs to know the importance of these areas and the management activities necessary to protect them. Public education through appropriate media coverage is crucial. Special efforts to communicate with public hunters who use these areas will be necessary.

Volunteer groups have proven successful in certain natural area management activities, especially in labor intensive efforts such as fence construction, weed control, and trail maintenance. These groups tend to be extremely motivated, representing a valuable resource for the Reserve manager.

Alternative Actions and Probable Impacts:

1) Do not attempt to inform the general public about the resources protected in the reserve or explain reasons for specific management actions. Do not use volunteer groups in relevant management activities in the reserve. The results of this alternative could include less public and legislative support for the NARS, misunderstanding among certain groups resulting in vandalism of capital improvements, and increased costs for overall NARS management, especially in plant control work.

2) Maintain community outreach program to give public presentations, provide informational material, and utilize concerned volunteer groups. This could result in cooperation with the general public in feral pig and non-native plant control programs and result in less expensive yet more effective management results. It could also provide a local constituency that would support reserve management activities.

Recommended Action: Inform the general public about resources within the Reserve and management activities through television, newspaper, and other local media outlets. Utilize volunteer groups for Reserve management whenever feasible. Present slide shows and talks to community groups. Develop a brochure that describes the resources and ongoing management activities within the Reserve.

Cost/Workload:

Year 1 - Personnel (20 PD)	\$ 1,700
Support and supplies	1,000
Total	\$ 2,700
Year 2 - Personnel (20 PD)	\$ 1,700
Support and supplies	1,000
Brochure	8,000
Total	\$10,700
Year 3-6 same as Year 1	Total \$ 2,700/year

D. Boundary Administration and Special Uses

Participation and cooperation among all adjacent landowners is an important factor for effective management of the West Maui Reserve. Many of the Reserve boundaries run along ridges and strategic fence locations straddle ownership boundaries. A West Maui management committee should be established and composed of representatives from affected state/private landowners (such as Maui Land and Pineapple who already have an active management program) and other concerned groups. The goal of the committee will be to coordinate current management activities, share management expertise, and plan future cooperative management efforts for the entire West Maui summit region. This plan will be sent to all involved parties and NARS staff will take the lead in coordinating this cooperative effort.

Kahakuloa and Makamakaole are the only two streams on West Maui which still carry water to the sea continuously. It is important to maintain the present physical and chemical quality of these streams to preserve the endangered endemic stream life. While existing regulations may be sufficient to prohibit the export of water from the Reserve, stream flows in the lower reaches of the streams outside the Reserve boundary must be maintained in order to provide a continuous migratory pathway into the Reserve. NARS staff should work with appropriate agencies and Commissions to establish appropriate permanent instream flow standards for both Kahakuloa and Makamakaole streams within and downstream of the Reserve. NARS staff should also work with appropriate agencies and landowners to maintain riparian forest cover, and stream bed materials and banks along portions of Kahakuloa and Makamakaole streams outside of the Reserve.

IV. BUDGET SUMMARY

When this plan was prepared, the long-term funding and organizational structure of the NARS had not been settled. Coordination and implementation of priority projects among the 18 Reserves may be affected by future organizational and funding decisions. This may require some revision in the priority projects described here.

A six-year implementation schedule is presented to accomplish management goals as efficiently as possible. Four management programs are proposed to achieve this. Although listed by priority, they build upon each other to form an integrated strategy.

The budget summary is based on a NARS integrated within the Division of Forestry and Wildlife. The budget summary shown is for the management of the West Maui NAR only. It does not include all the administrative, clerical, and facility support needed to run a state-wide NARS or to manage the other two natural area Reserves on the island of Maui. These infrastructure costs for the NARS will be identified and documented separately. Starting with year 3, an annual 1 percent inflation increase is incorporated into each total.

WEST MAUI NATURAL AREA RESERVE MANAGEMENT BUDGET SUMMARY

PROGRAM	YR 1	YR 2	YR 3	YR 4	YR 5	YR 6
WMA-RM-01						
Proj. 1	8,550	4,300	4,300	4,300	4,300	4,300
Proj. 2	5,300	10,600	13,250	15,900	15,900	15,900
Proj. 3	23,150	23,150	19,100	19,100	15,100	15,100
WMA-RM-02	11,000	11,000	11,000	11,000	11,000	11,000
WMA-RM-03	8,500	8,500	8,500	8,500	8,500	8,500
WMA-RM-04	2,700	10,700	2,700	2,700	2,700	2,700
TOTAL (\$)	59,200	68,250	59,500	62,800	59,300	58,800
<u>MANAGEMENT PROGRAMS</u> WMA-RM-01 - Ungulate Control (Priority 1) Project 1 - Fence Construction Project 2 - Fence Maintenance Project 3 - Feral Pig Removal WMA-RM-02 - Monitoring (Priority 2) WMA-RM-03 - Non-native Plant Control (Priority 3) WMA-RM-04 - Public Education and Volunteer Support(Priority 4)						
<u>PERSONNEL</u> (PD = person days) YR 1 - Reserve manager 109 PD YR 4 - Reserve manager 104 PD Technician 93 PD Technician 96 PD YR 2 - Reserve manager 105 PD YR 5 - Reserve manager 102 PD Technician 89 PD Technician 94 PD YR 3 - Reserve manager 104 PD YR 6 - Reserve manager 102 PD Technician 94 PD Technician 94 PD						

V. SOURCES CONSULTED

- Herbst, D. V. Personal Communication, June 1988. Endangered Species Botanist, Office of Environmental Services, U.S. Fish and Wildlife Service.
- Jacobi, J. D. 1985. Vegetation Maps of the Upland Plant Communities on the Islands of Hawaii, Maui, Molokai, and Lanai.
- Scott, M. J., S. Mountainspring, F. L. Ramsey, and C. B. Kepler. 1986. Forest Bird Communities of the Hawaiian Islands: Their Dynamics, Ecology, and Conservation. Studies in Avian Biology No. 9, Cooper Ornithological Society. Allen Press, Lawrence, Kansas.
- Severns, R. M. N.D. Unpublished Field Notes and Maps, 1978 - 1984.
- State of Hawaii. Hawaii Revised Statutes, Chapter 195-1.
- U.S. Fish and Wildlife Service. 1987. Endangered and Threatened Wildlife and Plants. 50 CFR 17.11 & 17.12. U.S. Government Printing Office, Washington, D.C.
- U.S. Fish and Wildlife Service. 1985. Federal Register. 50 CFR Part 17. Vol. 50; No. 188. Department of the Interior. U.S. Government Printing Office, Washington, D.C.
- Wagner, W. H. Jr. and F. S. Wagner. 1987. Revised Checklist of Hawaiian Pteridophytes.
- Wagner, W. L., D. R. Herbst and S. H. Sohmer. In Press. Manual of the Flowering Plants of Hawaii. Bishop Museum Press, Honolulu, Hawaii.

APPENDIX 1
West Maui Natural Area Reserve
Transect Specifications

Transect number	Transect length (ft)	No. of substations	Natural communities seen on transect
Lihau			
1	2,952	16	*Ohi'a Mixed Montane Wet Shrubland *Ohi'a Mixed Montane Wet Forest *Ohi'a Lowland Mesic Shrubland
2	3,116	17	*Ohi'a Mixed Montane Wet Shrubland *Ohi'a Mixed Montane Wet Forest *Ohi'a Lowland Mesic Shrubland
3	328	3	*Ohi'a Mixed Montane Wet Shrubland
4	7,216	42	*Ohi'a Mixed Montane Wet Forest *Ohi'a Lowland Mesic Shrubland *A'alii Lowland Dry Shrubland
Panaewa			
5	4,428	28	*Ohi'a Mixed Montane Wet Forest *Ohi'a Mixed Montane Bog
6	4,428	28	*Ohi'a Mixed Montane Bog *Ohi'a Mixed Montane Wet Forest
A	n/a	1	Mamaki Lowland Wet Shrubland
Honokowai			
7	11,480	71	*Ohi'a Mixed Montane Wet Forest *Ohi'a Mixed Montane Bog
8	6,068	38	Hawaiian Montane Lake *Ohi'a Mixed Montane Bog *Ohi'a Mixed Montane Wet Forest
9	2,132	14	*Ohi'a Mixed Montane Bog *Ohi'a Mixed Montane Wet Forest
B	n/a	1	*Ohi'a Mixed Montane Bog
Kahakuloa			
10	10,660	61	*Ohi'a Mixed Montane Bog *Ohi'a Mixed Montane Wet Forest
11	2,788	15	Hawaiian Montane Lake *Ohi'a Mixed Montane Bog *Ohi'a Mixed Montane Wet Shrubland *Ohi'a Mixed Montane Wet Forest
C	n/a	1	Mamaki Lowland Wet Shrubland

SURVEY PARTICIPANTS

Randy Bartlett, MPC, Supervisor
Marie Bruegmann, TNCH, Botanist
Bob Hobdy, DOFAW, Maui Deputy District Forester
Steve Perlman, TNCH, Field Coordinator

TNCH = The Nature Conservancy of Hawaii

MPC = Maui Pineapple Company, a division of Maui Land and Pineapple

TRANSECT SUBSTATION FIELD FORM Time Start: _____ End: _____ Date: _____

NAR Name: _____ NC Name: _____

Observer(s): _____ { Transect(s): _____

*COVER CLASS CODES:

1 = <1%	2 = 1-5%	3 = 5-25%
4 = 25-50%	5 = 50-75%	6 = 75-90%
7 =		

(FOR USE BELOW)

STATION NUMBER: _____

ITEM: _____

[illegible]

[illegible][illegible]

NATURAL COMMUNITY FIELD OBSERVATION FORM

DATE: _____ TIME START: _____ END: _____

TRANSECT#: _____ STATION#: _____ ELEVATION: _____

NAR NAME: _____ QUAD NAME: _____
 DATE: _____ ISLAND: _____ SITE NAME: _____
 SPECIES NAME: _____
 OBSERVER(S): _____
 PHOTO TAKEN: _____ Y _____ N _____
 SPECIMEN #, COLLECTOR, REPOSITORY: _____
 DIRECTIONS: _____

DIRECTIONS:

ELEVATION: _____

GENERAL DESCRIPTION OF AREA:

EODATA:

EODATA:

NATURAL COMMUNITY:

ASSOCIATED NATIVE SPECIES:

ASSOCIATED WEED SPECIES:

THREATS:

PROTECTION/MANAGEMENT RECOMMENDATIONS:

COMMENTS:

ASPECT		SLOPE	LIGHT	TOPOGRAPHIC POSITION	MOISTURE	DOMINANT SPECIES	%COVER
N	FLAT	DENSE	CREST	INUNDATED			
E	GENTLE	CLOSED	UPPER SLP	SATURATED			
S	MOD	OPEN	MID SLP	MOIST			
W	STEEP	SCATTER	LOW SLP	LOW-MESIC			
()	VERT	VERY SC	BOTTOM	DRY			

HABIT	PHENOLOGY	AGE STRUCTURE	VIGOR	FREQUENCY	POPULATION SIZE	POPULATION AREA (H)
TREE	IN LEAF	\$SD LGS	DYING	COMMON	ACTUAL	1
SHRUB	IN BUD	\$IMM	FEEBLE	OCCAS	1-10	1-5
HERB	IN FLOWER	\$HERB	NORMAL	\$MAT	10-50	5-10
VINE	IMM FRUIT	\$SENEC	VIGOROUS	SOL	50-100	10-100
PROST	MAT FRUIT				100-1000	100+
	DORMANT				1000+	

NATURAL COMMUNITY FIELD OBSERVATION FORM

DATE: _____ TIME START: _____ END: _____

TRANSECT#: _____ STATION#: _____ ELEVATION: _____

OBSERVER(S): _____
 NC NAME: _____
 NCAR NAME: _____
 SUBSTRATE: _____
 ADJ NCS: _____
 QUAD NAME: _____
 ECODE: _____

DESCRIPTION LINE:

DESCRIPTION LINE:

ASPECT		SLOPE	CANOPY CLOSURE	TOPOGRAPHIC POSITION	CANOPY STATURE	MOISTURE	NC AREA
N	FLAT	DENSE	CREST	<1M	INUNDATED	<1 AC	
E	GENTLE	CLOSED	UPPER SLP	1-2.5M	SATURATED	1-5 AC	
S	MOD	OPEN	MID SLP	2.5-5M	MOIST	6-10 AC	
W	STEEP	SCATTER	LOW SLP	5-10M	MOIST-DRY	>10 AC	
()	VERT	VERYSCL	BOTTOM	>10M	DRY	()	

COVER CLASS CODES:		
1 = <1%	2 = 1-5%	3 = 5-25%
4 = 25-50%	5 = 50-75%	6 = 75-90%
7 = >90%		

A.	CANOPY DOMINANTS:	T	S	H	*COVER	AVE DIA	REMARKS
	<u>SPECIES</u>					DIA	

[illegible]

B. SUBCANOPY DOMINANTS:		T S H *COVER		REMARKS
SPECIES				

[illegible]

LITTER: _____ BARE GROUND: _____ SPECIES LIST ATTACHED: Y N
THREATS: _____

PROTECTION/MANAGEMENT RECOMMENDATIONS:

RORANK; A = EXCELLENT B = FAIR-GOOD C = POOR D = DEGRADED
 EO BOUNDARIES MAPPED: Y N MAP ATTACHED: Y N PHOTO #:#

APPENDIX 3
RARE PLANTS OF WEST MAUI NATURAL AREA RESERVE

Scientific Name ¹ Former Name ² (Common Name)	Current (Historic) Occurrences ³	Federal Status ⁴	HHP Rank ⁵
IHAU SECTION			
<u>Achyranthes splendens</u> var. <u>splendens</u> (-)	1(0)	-	2
<u>Chamaesyce celastroides</u> var. <u>laehiensis</u> (`akoko)	1(0)	-	1
<u>Otenitis crinalis</u> (-)	1(0)	-	?
<u>Geranium humile</u> (hinahina, nohoanu)	1(0)	-	1-2
<u>Souania hillebrandii</u> (-)	1(0)	LE	1
<u>Hibiscus brackenridgei</u> ssp. <u>brackenridgei</u> <u>H. brackenridgei</u> (ma`o hau hele)	1(0)	- C1	1-2
<u>Superzia mannii</u> <u>Lycopodium mannii</u> (wawae `iole)	1(0)	- C1	1
<u>Ipochaeta lobata</u> var. <u>lobata</u> (nehe)	1(0)	-	2
<u>Ysimachia lydgatei</u> (-)	1(0)	-	1
<u>Hyllostegia stachyoides</u> (-)	1(0)	-	?
<u>Antalum freycinetianum</u> var. <u>lanaiense</u> (`ilihi)	1(0)	LE	2
<u>Chiedeia menziesii</u> <u>S. menziesii</u> var. <u>menziesii</u> <u>S. menziesii</u> var. <u>spergulacea</u> (ma`oli`oli)	1(0)	- C2 C2	1
<u>Permolepis hawaiiensis</u> (-)	1(0)	-	1
<u>Cisetum inaequale</u> (-)	1(0)	-	?

APPENDIX 3, Continued
RARE PLANTS OF WEST MAUI NATURAL AREA RESERVE

Scientific Name ¹ Former Name ² (Common Name)	Current (Historic) Occurrences ³	Federal Status ⁴	HHP Rank ⁵
PANAWEA SECTION			
<u>Acacia koaia</u> (koaia)	1(0)	C1	2
<u>Achyranthes splendens</u> var. <u>splendens</u> (-)	0(1)	-	2
<u>Cyanea kunthiana</u> (`ohawai, `oha, haha)	0(1)	C2	H
<u>Cyanea obtusa</u> (`ohawai, `oha, haha)	0(1)	-	H
<u>Diellia erecta</u> (-)	0(1)	C1	2
* <u>Eurya sandwicensis</u> E. <u>sandwicensis</u> var. <u>sandwicensis</u> (anini)	2(0)	- C1	2
<u>Exocarpus gaudichaudii</u> (heau)	0(1)	-	1
* <u>Geranium humile</u> (hinahina, nohoanu)	1(0)	-	1-2
<u>Gouania vitifolia</u> (-)	0(1)	C1	H
* <u>Lagenifera maviensis</u> (-)	2(0)	-	2
<u>Lipochaeta lobata</u> var. <u>lobata</u> (nehe)	0(1)	-	2
<u>Lobelia hypoleuca</u> L. <u>hypoleuca</u> var. <u>rockii</u> (mo`owahie)	0(1)	- C2	1
* <u>Myrsine vaccinioides</u> (kolea)	1(0)	-	1
<u>Plantago princeps</u> var. <u>laxiflora</u> (ale)	0(1)	C1	1
<u>Remya mauiensis</u> (-)	0(1)	C1	1
* <u>Sanicula purpurea</u> (-)	1(0)	-	2
<u>Sicyos cucumerinus</u> (`anunu)	0(1)	-	?

Key on page 5

APPENDIX 3, Continued
RARE PLANTS OF WEST MAUI NATURAL AREA RESERVE

Scientific Name ¹ Former Name ² (Common Name)	Current (Historic) Occurrences ³	Federal Status ⁴	HHP Rank ⁵
MONOKOWAI SECTION			
<u>Asplenium schizophyllum</u> (-)	1(0)	-	1
<u>Argyroxiphium caliginis</u> (Eke silversword)	2(0)	-	1
<u>Calamagrostis expansa</u> (-)	0(1)	-	2
<u>Calamagrostis hillebrandii</u> (-)	0(1)	-	1
<u>Clermontia oblongifolia</u> var. <u>mauiensis</u> (`oha, `ohawai)	1(0)	-	1
<u>Cyanea kunthiana</u> (`ohawai, `oha, haha)	0(1)	C2	H
<u>Cyanea scabra</u> (`ohawai, `oha, haha)	1(0)	C2	1
<u>Diellia erecta</u> (-)	0(1)	C1	2
<u>Doodia lyonii</u> (-)	0(1)	-	H
<u>Eurya sandwicensis</u> <u>E. sandwicensis</u> var. <u>grandifolia</u> (anini)	2(1)	- C1	2
<u>Geranium humile</u> (hinahina, nohoanu)	1(0)	-	1-2
<u>Joinvillea ascendens</u> ssp. <u>ascendens</u> (`ohe)	0(1)	-	1
<u>Lagenifera maviensis</u> (-)	3(0)	-	2
<u>Myrsine vaccinioides</u> (kolea)	1(0)	-	1
<u>Pelea orbicularis</u> (alani)	0(1)	C1	?
<u>Pelea parvifolia</u> <u>P. parvifolia</u> var. <u>apoda</u> <u>P. parvifolia</u> var. <u>sessile</u> (alani)	0(4)	- C1 C1	1
<u>Phyllostegia bracteata</u> (-)	0(1)	-	H
<u>Platanthera holochila</u> (-)	0(1)	C1	1-2
<u>Sanicula purpurea</u> (-)	1(0)	-	2

Key on page 5

APPENDIX 3, Continued
RARE PLANTS OF WEST MAUI NATURAL AREA RESERVE

Scientific Name ¹ Former Name ² (Common Name)	Current (Historic) Occurrences ³	Federal Status ⁴	HHP Rank ⁵
MAHAKULOA SECTION			
<u>Acaena exigua</u> (lili wai)	0(1)	C1	H
<u>Argyroxiphium caliginis</u> (Eke silversword)	1(0)	-	1
<u>Bidens conjuncta</u> (ko'oko'olau, koko'olau)	0(1)	-	H
<u>Calamagrostis expansa</u> (-)	1(0)	-	2
<u>Calamagrostis hillebrandii</u> (-)	2(0)	-	1
<u>Cyanea kunthiana</u> (`ohawai, `oha, haha)	0(1)	C2	H
<u>Geranium humile</u> (hinahina, nohoanu)	0(1)	-	1-2
<u>Hibiscus kokio</u> var. <u>kokio</u> (koki'o, `ula`ula)	1(0)	C2	1
<u>Isoetes hawaiiensis</u> (-)	1(0)	-	1
<u>Joinvillea ascendens</u> ssp. <u>ascendens</u> (`ohe)	1(0)	-	1
<u>Lagenifera maviensis</u> (-)	2(0)	-	2
<u>Myrsine vaccinioides</u> (kolea)	1(0)	-	1
<u>Pelea orbicularis</u> (alani)	0(1)	C1	?
<u>Pelea parvifolia</u> P. <u>parvifolia</u> var. <u>apoda</u> P. <u>parvifolia</u> var. <u>sessile</u> (alani)	0(1)	- C1 C1	1
<u>Platanthera holochila</u> (-)	0(1)	-	1-2
<u>Scaevola hobbdi</u> (naupaka)	1(0)	-	1
<u>Wikstroemia bicornuta</u> (`akia)	1(0)	-	1

Key on page 5

* Observed during 1988 survey

¹ Wagner et al. (in press)
Wagner and Wagner (1987)

² Taxonomy used in 1985 Federal Register

³ Current occurrences reported since 1972

⁴ Key to Federal Status (USFWS 1985, 1987):

C1 Candidate for endangered or threatened status

C2 Candidate for endangered or threatened status, information lacking

LE Endangered

- No federal status. Described as rare by Hawaiian botanists and confirmed by Heritage data

⁵ Key to Hawaii Heritage Program Ranks:

¹ Critically imperilled globally (typically 1-5 occurrences)

² Imperilled globally (typically 6-20 occurrences)

[?] No more than 100 occurrences globally; rank not yet determined by HHP

^H Historically known (no observations since 1972 throughout its range, but could be rediscovered)

APPENDIX 4

This species list was compiled from available literature sources, personal communication with botanists familiar with the area (backed by specimen verification for rare plants), and field identification during this NARS field survey. Rare plants (less than 3,000 individuals, or known from fewer than 20 locations worldwide) with specific location information are noted by '+' and are either in the reserve or its adjacent area (see Appendix 3 for those confirmed in the reserve). Rare plants thought to occur in the reserve, but which lack specific location information are noted by '#' in the first column.

Due to subjective location information, some plant species included on this list may not actually be present in the reserve. Plants reported for the area without an associated vegetation type are assigned to the natural community they would most likely occur in with a '?'.

Descriptions of natural communities are in the text. Taxonomy follows Wagner et al. (in press) and Wagner and Wagner (1987).

The following abbreviations explain the species list of vascular plants found in the area of the West Maui Natural Reserve:

+ = Rare # = Rare and reported for area; specific location information lacking.

N = Non-native I = Indigenous E = Endemic

x = Cited in literature for area within natural community type
 ? = Cited in literature; needs confirmation in natural community
 H = Confirmed during NARS survey in Honokowai section
 K = Confirmed during NARS survey in Kahakuloa section
 L = Confirmed during NARS survey in Lihau section
 P = Confirmed during NARS survey in Panaewa section

APPENDIX 4
West Maui Area
Vascular Plant Species List

This species list was compiled from available literature sources, personal communication with botanists familiar with the area (backed by specimen verification for rare plants), and field identification during this NARS field survey. Rare plants (less than 3,000 individuals, or known from fewer than 20 locations worldwide) with specific location information are noted by '+' and are either in the Reserve or its adjacent area (see the rare plants table for those confirmed in the Reserve). Rare plants thought to occur in the Reserve but which lack specific location information are noted by '#' in the status column.

Due to subjective location information, some plant species included on this list may not actually be present in the Reserve. Plants and their associated vegetation types reported from literature for the area, but not confirmed during this survey, are noted with an 'x'. Plants reported for the area without an associated vegetation type are assigned to the natural community they would most likely occur in with a '?'.

Descriptions of natural communities are in the text. Taxonomy follows Wagner et al. (in press) and Wagner and Wagner (1987).

Status	Taxon	'A'ali'i Lowland Dry Shrubland	Mamaki Lowland Wet Shrubland	Mixed Sedge/Grass Montane Bog	'Ohia' Mixed Montane Bog	'Ohia' Lowland Mesic Shrubland	Mixed Fern/Shrub Montane Wet Cliffs	'Ohia' Mixed Shrub Montane Wet Forest	'Ohia'/Olapa Montane Wet Forest	'Ohia'/Uluhe Montane Wet Forest	'Ohia' Mixed Montane Wet Shrubland
E	Acacia koa					L				x	
E	Acacia koaia					?					
E	Acaena exigua			?	?						
E	Achyranthes splendens var. splendens	L	P								
E	Adenophorus abietinus				x			?	?	x	
E	Adenophorus hymenophylloides							H	x	x	
E	Adenophorus pinnatifidus							HL	K	x	
E	Adenophorus tamariscinus				HP			HKL	HP	K	HK
E	Adenophorus tripinnatifidus				x			HK	K		
I	Adiantum capillus-veneris		P								
N	Adiantum cuneatum		P								
N	Adiantum hispidulum		P								
N	Ageratina adenophora		P		HKP	L		HKL	HP	x	HKL

+ = Rare N = Non-native I = Indigenous E = Endemic

* = Confirmed in NARS field study x = Cited in literature sources

? = Cited in literature sources; needs confirmation in natural community

Status - Taxon

	'A'ali'i Lowland Dry Shrubland	Mamaki Lowland Wet Shrubland	Mixed Sedge/Grass Montane Bog	'Oh'i'a Mixed Montane Bog	'Oh'i'a Lowland Mestic Shrubland	Mixed Fern/Shrub Montane Wet Cliffs	'Oh'i'a Mixed Shrub Montane Wet Fores	'Oh'i'a/Olapa Montane Wet Fores	'Oh'i'a/Uluhe Montane Wet Fores	'Oh'i'a Mixed Montar Wet Shrubland
N Ageratina riparia					L					
N Ageratum conyzoides							x	x	x	K
? Agrostis sp.					L					
E Alectryon macrococcus var. ? macrococcus					?				?	
N Aleurites moluccana		K								
E Alyxia oliviformis							HL	x	L	
N Andropogon virginicus				K	x		HKL	K	x	KL
E Anoectochilus sandvicensis				x			H	?		
E Antidesma platyphyllum		KP			x		x	x	x	
E Antidesma sp.					x		x	x	x	
N Araucaria sp.									x	
E Argyroxiphium caliginis				HK						K
E Argyroxiphium grayanum				HKP			HP	P		HK
E Artemisia sp.					L					
E Asplenium acuminatum							HKL	P		
E Asplenium contiguum				KP			HL	KP		
E Asplenium falcatum							H	x		
E Asplenium lobulatum							KL	x	x	K
I Asplenium nidus		K								
? Asplenium polydon							L	P		
E Asplenium schizophyllum								x		
? Asplenium sp.					L		?	x	x	
E Asplenium unilaterale								P		
E Astelia menziesiana				H			HL	P	x	H
E Athyrium arnottii							L			K
E Athyrium fenzlieanum		P					H			
N Athyrium japonicum		P					H			
E Athyrium microphyllum				HP	x		HKL	P	K	HK
E Athyrium sandwichianum		KP		x	x		HL	P	x	K
E Bidens conjuncta	?				?		?		?	
E Bidens mauiensis	?				?		?		?	
E Bidens menziesii	L				L					
E Bidens micrantha ssp. kalealaha	?	?			?		?		?	
E Bidens sandvicensis					x					
E Bidens sp.		P			L		?	KP	K	
N Blechnum occidentale		KP						x		
E Bobea elatior								x		
E Bobea sandwicensis								x	x	
E Boehmeria grandis		KP		x					x	
E Bonamia menziesii	?						?		?	
E Broussaisia arguta				HKP	L		HL	HKP	KL	HK
N Buddleia asiatica		KP					L			
E Calamagrostis expansa			?	?		?	?	?	?	?

+ = Rare N = Non-native I = Indigenous E = Endemic

* = Confirmed in NARS field study x = Cited in literature sources
 ? = Cited in literature sources; needs confirmation in natural community

tatus Taxon

	'A'ali'i Lowland Dry Shrubland	Mamaki Lowland Wet Shrubland	Mixed Sedge/Grass Montane Bog	'Ohi'a Mixed Montane Bog	'Ohi'a Lowland Mesic Shrubland	Mixed Fern/Shrub Montane Wet Cliffs	'Ohi'a Mixed Shrub Montane Wet Forest	'Ohi'a/Oleapa Montane Wet Forest	'Ohi'a/Uluhe Montane Wet Forest	'Ohi'a Mixed Montane Wet Shrubland
E Calamagrostis hillebrandii				x						
? Calamagrostis sp.								x		
E Callistopteris baldwinii							?	P		
E Capparis sandwichiana		P								
E Carex alligata				HP			HL	HP	x	HK
I Carex meyenii		P					L			
E Carex montis-eeka			H	HKP			?	P		HK
E Carex wahuensis		P					L			
N Castilleja arvensis									x	
N Casuarina equisetifolia					L					
N Centauria sp.	L									
N Centella asiatica		K					HK	x	K	K
N Cerastium sp.					L		L			
N Chamaecrista nictitans	L				L					
E Chamaesyce celastroides var. laehiensis	?				?				?	
E Chamaesyce olowaluana	?				?				?	
E Charpentiera obovata		P								
E Cheirodendron trigynum				HKP	L		HKL	HKP	KL	HK
E Cibotium chamissoi				x			L	K	x	
E Cibotium glaucum		PK		HKP			HL	K	x	HK
E Cibotium splendens							?	x	L	
N Cirsium vulgare							L			
E Claoxylon sp.		P								
E Clermontia arborescens							L		x	
E Clermontia grandiflora				HK			H	P	H	HK
E Clermontia kakeana								x		
E Clermontia micrantha								K	K	K
E Clermontia multiflora			?	?		?	?	?	?	
E Clermontia oblongifolia ssp. mauiensis			?	?	?	?	?	?	?	
E Clermontia sp.				x	x		K	P	x	
I Cocculus trilobus					x				x	
N Colocasia esculenta		KP								
N Commelina diffusa					x			x		
E Coniogramme pilosa							L	P	L	
N Conyza bonariensis										L
N Conyza canadensis	L				L		L			
E Coprosma foliosa					L		HL			
E Coprosma ochracea				HKP	x		P	P	x	H
N Cordyline fruticosa		KP							x	
N Cryptomeria japonica				H			H	x	x	H
E Ctenitis crinalis			?	?		?	?	?	?	?
E Ctenitis honoluluensis				x			L	P	x	
E Ctenitis rubiginosa			H	P			HKL	HP		H

= Rare N = Non-native I = Indigenous E = Endemic

= Confirmed in NARS field study x = Cited in literature sources

= Cited in literature sources; needs confirmation in natural community

Status	Taxon	'A'ali Lowland Dry Shrubland	Mamak Lowland Wet Shrubland	Mixed Sedge/Grass Montane Bog	'Ohia Mixed Montane Bog	'Ohia Lowland Mesic Shrubland	Mixed Fern/Shrub Montane Wet Cliffs	'Ohia Mixed Shrub Montane Wet Fores	'Ohia/Olapa Montane Wet Fores	'Ohia/Uluhe Montane Wet Fores	'Ohia Mixed Montai Wet Shrubland
+	E Ctenitis squamigera			?	?		?	?	?	?	?
	N Cuphea carthagenensis							K		x	
	E Cyanea angustifolia									K	
+	E Cyanea asplenifolia			?	?		?	?	?	?	?
+	E Cyanea grimesiana ssp. grimesiana			?	?		?	?	?	?	?
+	E Cyanea kunthiana							?	?		
+	E Cyanea lobata			?	?		?	?	?	?	?
	E Cyanea macrostegia ssp. macrostegia							HL	P		
+	E Cyanea obtusa							?	?	?	
	E Cyanea pilosa				x			H	P		
+	E Cyanea scabra							H			
	E Cyanea sp.				x			x	P	x	
	N Cyperus halpan								K	x	K
	? Cyperus sp.					x		L	x	x	
	E Cyrtandra filipes			?	?		?	?	?	?	?
	E Cyrtandra grayana							HK	H	P	K
	E Cyrtandra grayi							L			
	E Cyrtandra longifolia				P				P		
+	E Cyrtandra lydgatei			?	?		?	?	?	?	?
	E Cyrtandra paludosa		P							x	
	E Cyrtandra platyphylla							L	x	x	
	E Cyrtandra sp.		KP		x			L	x	x	
	E Cyrtandra spathulata		P					L			
	E Cystopteris douglasii			?	?		?	?	?	?	?
+	E Delissea undulata ssp. undulata			?	?		?	?	?	?	?
	E Deschampsia nubigena			H	HKP	x		L	P	L	HK
	E Desmodium sandwicense									x	
	N Desmodium sp.									x	
	E Dianella sandwicensis					L			x	L	
	E Dichantherium cynodon				K						K
	E Dichantherium hillebrandianum			H	HK				P		H
	E Dichantherium isachnoides				K						K
	I Dicranopteris linearis		K		HKP	L	x	HKL	HK	KL	HKL
+	E Diellia erecta		?	?	?	?	?	?	?	?	?
	N Digitaria sp.					x				x	
	N Dioscorea sp.		K					x			
	E Diospyros hillebrandii									x	
+	E Diplazium molokaiense	?	?	?	?	?	?	?	?	?	?
	I Diplopterygium pinnatum				KP	L	x	HL	HKP	K	HK
+	E Dissochondrus biflorus	?				?				?	
	E Dodonaea viscosa	L				L		HL	x	L	

+ = Rare N = Non-native I = Indigenous E = Endemic

* = Confirmed in NARS field study x = Cited in literature sources
 ? = Cited in literature sources; needs confirmation in natural community

Status Taxon

	'A'ali'i Lowland Dry Shrubland	Mamaki Lowland Wet Shrubland	Mixed Sedge/Grass Montane Bog	'Ohi'a Mixed Montane Bog	'Ohi'a Lowland Mesic Shrubland	Mixed Fern/Shrub Montane Wet Cliffs	'Ohi'a Mixed Shrub Montane Wet Forest	'Ohi'a/Olapa Montane Wet Forest	'Ohi'a/Uluhe Montane Wet Forest	'Ohi'a Mixed Montan Wet Shrubland
E Doodia kunthiana	?	?	?	?	?	?	?	?	?	?
E Doodia lyonii	?	?	?	?	?	?	?	?	?	?
E Doryopteris decipiens	L									
N Drymaria cordata var. pacifica		P						x	x	
E Dryopteris acutidens				P			HKL	P		
E Dryopteris fusco-atra				P			HKL	x	x	K
E Dryopteris glabra				HP			HKL	P		L
E Dryopteris insularis			?	?		?	?	?	?	?
E Dryopteris sandwicensis								HP		
? Dryopteris sp.				x			?	P	x	
E Dryopteris subbipinnata				P				HP		
? Dryopteris unidentata				x	L		L	x	x	
E Dryopteris wallichiana				P			HKL	H		
E Dubautia laxa				HP			HK	HP	K	HK
E Dubautia linearis					L					
E Dubautia plantaginea				P			L	P	L	
N Dubautia scabra										L
E Dubautia scabra x							L			
E Dubautia sp.							?	x		
I Elaphoglossum alatum							HKL	H	x	K
E Elaphoglossum crassifolium				x			KL	x	x	
E Elaphoglossum hirtum				HP			HKL	HP	x	HK
E Elaphoglossum pellucidum								x		
E Elaphoglossum wawrae				PH			HL	KP	x	H
E Embelia pacifica							H	P	x	
N Emilia sonchifolia var. javanica					L					
N Epidendrum sp.					L					
N Epilobium sp.									x	
E Eragrostis atropioides	?						?		?	
E Eragrostis grandis				KP			L	P		KL
E Eragrostis monticola	L									
E Eragrostis variabilis					L		?	?		
N Erechites valerianifolia							HK	HK	x	K
N Erigeron sp.					x		x		x	
E Erythrina sandwicensis	?									
E Eurya sandwicensis				H	H		?	P		H
E Exocarpos gaudichaudii	?	?			?		?		?	
E Freycinetia arborea		P		K	L		HK	K	x	K
E Gahnia beecheyi				KP	x		H	x		
E Gardenia brighamii	?				?					
E Gardenia remyi		?		K	?		?		?	
E Geranium humile			H	HP	L			P		
N Gnaphalium purpureum					L			x		

+ = Rare N = Non-native I = Indigenous E = Endemic

* = Confirmed in NARS field study x = Cited in literature sources
 ? = Cited in literature sources; needs confirmation in natural community

Status	Taxon	'A'ii'i Lowland Dry Shrubland	Mamaki Lowland Wet Shrubland	Mixed Sedge/Grass Montane Bog	'Ohia' Mixed Montane Bog	'Ohia' Lowland Mesic Shrubland	Mixed Fern/Shrub Montane Wet Cliff	'Ohia' Mixed Shrub Montane Wet For.	'Ohia' Olapa Montane Wet For.	'Ohia' Uluhe Montane Wet For.	'Ohia' Mixed Mont Wet Shrubland
+	E Gouania hillebrandii	L									
+	E Gouania vitifolia	?				?				?	
	E Grammitis hookeri				x			L	P	x	
	E Grammitis tenella							HL	K	K	
	N Grevillea robusta		P			x					
	E Gunnera petaloidea				x		x	H	P		K
	E Hedyotis acuminata		KP								
	E Hedyotis centranthoides		P		x	L		L		L	L
+	E Hedyotis formosa						?				?
	E Hedyotis hillebrandii							?	?		
#	E Hedyotis mannii										
	E Hedyotis sp.					x		x	x	?	
	E Hedyotis terminalis		P					HKL	KP	K	L
+	E Hesperomannia arbuscula		?			?	?	?	?	?	?
	I Heteropogon contortus	L				L					
+	E Hibiscus brackenridgei	?								?	
	ssp. brackenridgei										
+	E Hibiscus kokio ssp. kokio		K								
	N Holcus lanatus								x		
+	E Huperzia mannii							L			
	I Huperzia phyllanthum							H	x		
	I Huperzia polytrichoides							L	x		
	I Huperzia serrata							H	x		
	I Huperzia somai							K			
	E Huperzia sulcinervia										K
	N Hypochoeris radicata				HKP	x		HL	HP	K	HL
	E Hypolepis hawaiiensis							K			
	E Ilex anomala				HP	L		HKL	HKP	x	HK
	N Indigofera sp.					L					
	N Ipomoea alba		P								
	I Ipomoea indica		P		K				x	x	
	E Isachne distichophylla				K			K	x		K
	? Isachne sp.				x				x	x	
+	E Isodendron pyriformum	?				?					
+	E Isoetes hawaiiensis				K						
+	E Joinvillea ascendens spp. ascendens								x		
	N Juncus bufonius				x			?	?		
	N Juncus effusus				HK			H			H
	N Juncus planifolius										K
	E Korthalsella cylindrica					L			P	x	H
	E Korthalsella sp.					x		L	P		
	N Kyllinga brevifolia					x		x	x	K	
	I Kyllinga brevifolia								x		
	E Labordia hedyosmifolia							KL			

+ = Rare N = Non-native I = Indigenous E = Endemic

* = Confirmed in NARS field study x = Cited in literature sources
 ? = Cited in literature sources; needs confirmation in natural community

Status - Taxon

	'A'ali'i Lowland Dry Shrubland	Mamaki Lowland Wet Shrubland	Mixed Sedge/Grass: Montane Bog	'Ohi'a Mixed Montane Bog	'Ohi'a Lowland Mesic Shrubland	Mixed Fern/Shrub Montane Wet Cliffs	'Ohi'a Mixed Shrub Montane Wet Fore	'Ohi'a/Olapa Montane Wet Fore	'Ohi'a/Uluhe Montane Wet Fore	'Ohi'a Mixed Montane Wet Shrubland
E Labordia hirtella							H			
E Labordia sp.				HP			H	HP	L	HK
E Labordia venosa								P		
E Lagenifera maviensis			H	HKP			?	P		H
N Lantana camara		P							x	
N Lapsana communis									x	
N Leucaena leucocephala	L									
E Liparis hawaiiensis							HL	x		
E Lipochaeta lavarum	L									
E Lipochaeta lobata var. lobata	L									
E Lobelia gaudichaudii				x			?	P	x	K
E Lobelia gloria-montis				HKP			H	P		HK
E Lobelia hillebrandii								P		L
E Lobelia hypoleuca			?	?		?	?	?	?	?
E Lobelia sp.				x			L	K		
N Ludwigia octovalvis								x		
E Luzula hawaiiensis				HKP	L		L			HL
I Lycopodium cernuum				HKP	x		HKL	HKP	L	HKL
I Lycopodium venustulum				P			HL	HP		
E Lysimachia lydgatei	?	?	?	?	?	?	?	?	?	?
E Lysimachia remyi					L					
E Lysimachia sp.					L		L	P		L
N Lythrum maritimum		P			L		HL	x	L	HL
I Machaerina angustifolia		K	H	HKP	L		HKL	KP	K	HKL
E Machaerina gahniiformis					L					
I Machaerina mariscoides							x	x	x	
N Mangifera indica		P								
E Marattia douglasii				P			HL	H	x	
E Mariscus hillebrandii	L									
E Mariscus hypochlorus										L
E Mariscus kunthianus			?	?		?	?	?	?	?
E Mariscus pennatifolius	?									
E Mecodium recurvum							K	x	x	K
N Melaleuca quinquenervia							L		x	
N Melinis minutiflora					x				x	
E Metrosideros polymorpha	L	KP	H	HKP	L		HKL	HKP	KL	HKL
N Microlepidia sp.							?	?	?	
E Microsorium spectrum		P					L	x		
E Morinda trimera	?				?					
N Musa sp.		P							x	
I Myoporum sandwicense	L									
E Myrsine denticulata				x						
E Myrsine emarginata				H	L			P		
E Myrsine lanaiensis							H	?	?	

+ = Rare N = Non-native I = Indigenous E = Endemic

* = Confirmed in NARS field study x = Cited in literature sources

? = Cited in literature sources; needs confirmation in natural community

Status Taxon

	'A'ali'i Lowland Dry Shrubland	Mamaki Lowland Wet Shrubland	Mixed Sedge/Grass Montane Bog	'Oh'i'a Mixed Montane Bog	'Oh'i'a Lowland Mesic Shrubland	Mixed Fern/Shrub Montane Wet Cliffs	'Oh'i'a Mixed Shrub Montane Wet Forest	'Oh'i'a/Olapa Montane Wet Forest	'Oh'i'a/Uluhe Montane Wet Forest	'Oh'i'a Mixed Montane Wet Shrubland
E Myrsine lessertiana					L		HKL	P	L	HK
E Myrsine sandwicensis				HKP	L		HKL	P	L	
+ E Myrsine vaccinioides				HKP			?	?	x	H
I Nephrolepis cordifolia							KL	x	KL	
N Nephrolepis exaltata		P					HL	x	x	
N Nephrolepis multiflora		K								
+ E Neraudia melastomifolia					?				?	
+ E Neraudia sericea	?				?				?	
I Nertera granadensis				HP			HK	HP	x	H
+ E Nesoluma polynesicum	?				?				?	
+ E Nothocestrum latifolium	?				?				?	
E Nototrichium sandwicense		P								
I Odontosoria chinensis				K	L		K	?	x	KL
? Ophioglossum sp.								x	x	
N Oplismenus sp.		P			x				x	
N Opuntia ficus-indica	L				L					
E Oreobolus furcatus			H	HKP				P		H
I Osteomeles anthyllidifolia	L				L		?	?	x	
? Panicum sp.				K			?	x		K
N Paspalum conjugatum				K	x		HK	x	K	K
N Paspalum scrobiculatum					L		?	?		
N Paspalum urvillei									K	K
N Passiflora edulis		P						x		
N Passiflora sp.									x	
N Passiflora suberosa		P								
E Pelea clusiifolia				HKP			HK	HP	K	HK
+ E Pelea hawaiiensis					?					
+ E Pelea orbicularis			?	?		?	?	?	?	?
+ E Pelea parvifolia			?	?		?	?	?	?	?
E Pelea sp.				HP			HL	P	x	H
E Peperomia eekana				P			KL	x	x	
+ E Peperomia expallescens							?	?	?	
E Peperomia hertipetiolata							K			K
E Peperomia macraeana									x	
E Peperomia mauiensis								x		
E Peperomia ovatilimba							K			
E Peperomia spp.				H			HL	HP	K	HK
E Perrottetia sandwicensis							L	x	L	
N Phaius tankarvilleae									x	
+ E Phyllostegia bracteata							?	?	?	
E Phyllostegia sp.								P		
+ E Phyllostegia stachyoides							L			
? Phytolacca sp.							L			
N Piper methysticum		KP								
E Pipturus albidus		KP			L		L	P	x	

+ = Rare N = Non-native I = Indigenous E = Endemic

* = Confirmed in NARS field study x = Cited in literature sources
 ? = Cited in literature sources; needs confirmation in natural community

Status Taxon

	'A'ali'i Lowland Dry Shrubland	Mamaki Lowland Wet Shrubland	Mixed Sedge/Grass Montane Bog	'Ohi'a Mixed Montane Bog	'Ohi'a Lowland Mesic Shrubland	Mixed Fern/Shrub Montane Wet Cliffs	'Ohi'a Mixed Shrub Montane Wet Fore	'Ohi'a/Olapa Montane Wet Fore	'Ohi'a/Uluhe Montane Wet Fore	'Ohi'a Mixed Montane Wet Shrubland
I <i>Pisonia umbellifera</i>	P									
N <i>Pithecellobium dulce</i>					L					
E <i>Pittosporum glabrum</i>				K			H	x	K	
N <i>Pityrogramma</i> sp.					L		K	?		L
N <i>Plantago australis</i> ssp. <i>hirtella</i>								x		
E <i>Plantago pachyphylla</i>			H	HKP			H	P		HK
E <i>Plantago princeps</i> var. <i>laxiflora</i>			?	?		?	?	?	?	?
? <i>Plantago</i> sp.				x			?	x	x	
E <i>Platanthera holochila</i>							?	?	x	
E <i>Pleomele auwahiensis</i>									x	
I <i>Pleopeltis thunbergiana</i>				HP			HL	P		H
N <i>Pluchea symphytifolia</i>									x	
E <i>Polypodium pellucidum</i>				HP	L		HKL	P		H
E <i>Portulaca</i> sp. A	?				?				?	
E <i>Pritchardia glabrata</i>						?	?	?	?	
E <i>Pritchardia</i> sp.								x	x	
N <i>Prosopis pallida</i>	?									
N <i>Psidium cattleianum</i>		KP						x		
N <i>Psidium guajava</i>		KP					x		x	
I <i>Psilotum complanatum</i>								x		
I <i>Psilotum nudum</i>							HL	x	x	
E <i>Psychotria maritima</i>							HL	P	L	
E <i>Psychotria mauiensis</i>		K					?	x	x	
E <i>Psychotria</i> sp.		P		K			HL	x	L	
E <i>Pteridium complanatum</i>					x		HL	P	K	
I <i>Pteris excelsa</i>					L					
E <i>Pteris lidgatii</i>						?	?	?	?	?
I <i>Pycnanthemum polystachyos</i>					?	?	?	x	?	
E <i>Ranunculus mauiensis</i>					?	?	?	?	?	
E <i>Remya mauiensis</i>					?		?			
N <i>Rhynchelytrum repens</i>	L				L				x	
E <i>Rhynchospora chinensis</i> ssp. <i>spiciformis</i>			H	HK					x	
N <i>Rubus argutus</i>							H	x	x	
E <i>Rubus hawaiiensis</i>							H	HP	x	
N <i>Rubus rosifolius</i>		KP			x		HKL	x	K	
N <i>Sacciolepis indica</i>				K			HK	x	KL	K
E <i>Sadleria cyatheoides</i>		KP	H	H	L	x	HL	HP	KL	HK
E <i>Sadleria pallida</i>				HKP		x	HKL	P	KL	HK
E <i>Sadleria souleyetiana</i>				P		x	HL	P	x	H
E <i>Sadleria squarrosa</i>						?	K	x		
E <i>Sanicula purpurea</i>				HP				P		
E <i>Santalum freycinetianum</i>					L				L	

+ = Rare N = Non-native I = Indigenous E = Endemic

* = Confirmed in NARS field study x = Cited in literature sources
 ? = Cited in literature sources; needs confirmation in natural community

Status Taxon

	'A'ali'i Lowland Dry Shrubland	Mamaki Lowland Wet Shrubland	Mixed Sedge/Grass Montane Bog	'Ohi'a Mixed Montane Bog	'Ohi'a Lowland Mesic Shrubland	Mixed Fern/Shrub Montane Wet Cliffs	'Ohi'a Mixed Shrub Montane Wet Fore	'Ohi'a/Olapa Montane Wet Fore	'Ohi'a/Uluhe Montane Wet Fore	'Ohi'a Mixed Montane Wet Shrubland
ssp. lanaiensis							?	?		
E Santalum sp.				K	L		HKL		KL	K
E Scaevola chamissoniana								x		
E Scaevola glabra				x						
+ E Scaevola hobbnyi				x	x		?	x		
E Scaevola sp.					L					
+ E Schiedea menziesii	L				?				?	
+ E Schiedea pubescens var. pubescens	?									
+ E Schiedea salicaria	?				?				?	
N Schinus terebinthifolius				H			?	x	K	K
E Schizaea robusta					x		x	x		
? Scirpus sp.							L		x	
E Selaginella arbuscula		K		x			?	x		HK
E Selaginella deflexa				HP						
+ E Sesbania tomentosa	?			K	x		x	x	x	
N Setaria gracilis							L			
N Setaria sp.								x		
N Setaria verticillata							?	?	?	
+ E Sicyos cucumerinus										
? Sida sp.	L									
E Smilax melastomifolia				KP	L		HKL	P	KL	
N Solanum americanum		P					L			
N Sonchus oleraceus									x	
N Spathoglottis plicata										
+ E Spermodermis hawaiiensis	L						?	P	K	H
E Sphaerocarpum lanceolatum				HK				x	x	
E Sphaerocarpum obtusum								x		
? Sporobolus sp.										
E Stenogyne kamehamehae				HKP			HKL	HP	x	H
E Stenogyne sessilis							L			
E Stenogyne sp.				x			?	x	?	
+ E Stenogyne viridis						?	?	?	?	
E Sticherus owhyensis				P	L	x	HL	P	KL	
E Styphelia tameiameia	L		H	HKP	L		HL	HP	x	HL
N Syzygium jambos		K								
N Syzygium sp.		K					x	x	x	
E Tectaria gaudichaudii		KP								
+ E Tetramolopium capillare	?				?					
E Tetraplasandra oahuensis				K			HK	P	K	
E Tetraplasandra sp.								x		
I Thelypteris cyatheoides		KP					L	?		
N Thelypteris dentata		K								
E Thelypteris hudsoniana		P								
E Thelypteris keraudreniana							L	P	L	

+ = Rare N = Non-native I = Indigenous E = Endemic

* = Confirmed in NARS field study x = Cited in literature sources
 ? = Cited in literature sources; needs confirmation in natural community

Status Taxon

	'A'ali'i Lowland Dry Shrubland	Mamaki Lowland Wet Shrubland	Mixed Sedge/Grass Montane Bog	'Ohi'a Mixed Montane Bog	'Ohi'a Lowland Mesic Shrubland	Mixed Fern/Shrub Montane Wet Cliffs	'Ohi'a Mixed Shrub Montane Wet Forest	'Ohi'a/Olapa Montane Wet Forest	'Ohi'a/Uluhe Montane Wet Forest	'Ohi'a Mixed Montane Wet Shrubland
N Thelypteris parasitica		K					K			
E Thelypteris sandwicensis		KP		P			HL	P	x	H
N Tibouchina herbacea				HKP			HK	P	K	K
? Toppingia sp.							?	x	?	
E Touchardia latifolia		KP								
E Trematolobelia macrostachys										H
E Trematolobelia sp.							H	x	K	H
+ E Trisetum inaequale	?				?		?			
? Trisetum sp.				x	x					
I Uncinia uncinata				x			HL	HP	x	
E Urera glabra		P								
E Vaccinium calycinum				HKP	L		HKL	HP	K	HL
E Vaccinium dentatum								x	x	
E Vaccinium reticulatum				x			?	?		
? Vaccinium sp.				x	x		?	x	x	
E Vandenboschia cyrtotheca		K								
E Vandenboschia davallioides							HL	x		
N Verbena littoralis		P					L			L
E Viola maviensis				HKP						K
I Waltheria indica	L									
+ E Wikstroemia bicornuta				K						K
E Wikstroemia oahuensis var. oahuensis					L		L			
E Wikstroemia sp.		P		x	L		HL	P	x	K
+ E Wikstroemia villosa							?	?	?	
E Xiphopteris saffordii				HP			HL	HP	L	L
E Xylosma sp.		P								
N Youngia japonica		P					HL	x		
N Zingiber zerumbet		K							x	

+ = Rare

N = Non-native

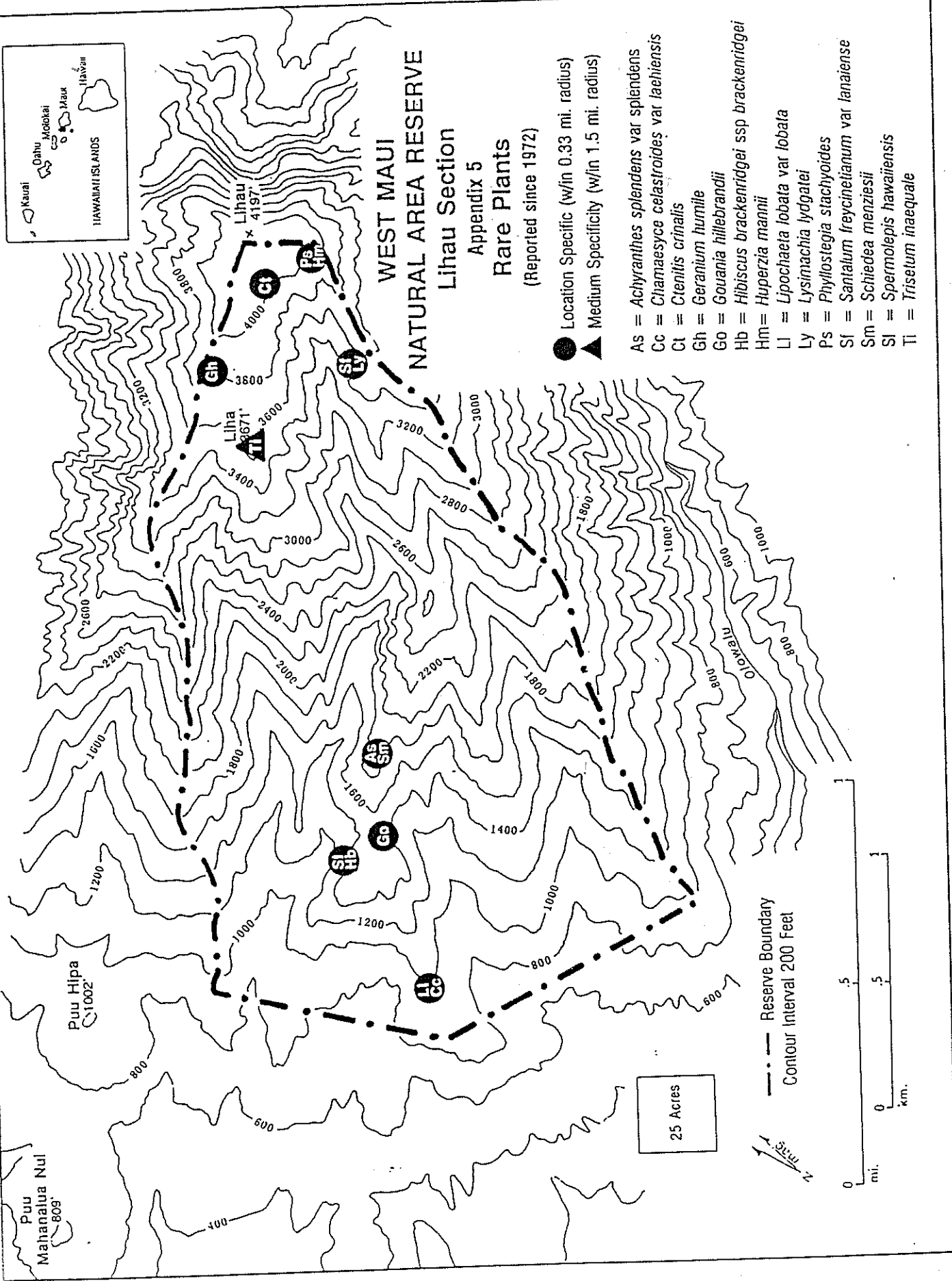
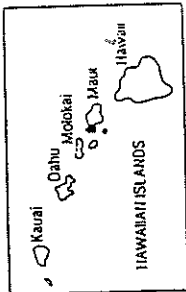
I = Indigenous

E = Endemic

* = Confirmed in NARS field study

x = Cited in literature sources

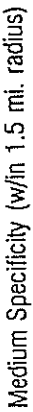
? = Cited in literature sources; needs confirmation in natural community



WEST MAUI

Appendix 5

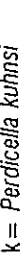
(Reported since 1972)



Land Snails

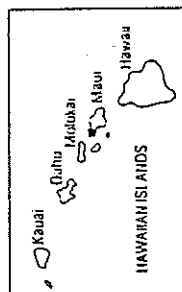
Ak = *Acacia koa*
Es = *Eurya sandwicensis*
Gh = *Geranium humile*
Lm = *Lagenifera maviensis*
Mv = *Myrsine vaccinioides*
Sp = *Sanicula purpurea*

g = *Partulina gouldii*
p = *Partulina perdit*
s = *Partulina splendida*
t = *Partulina tappaniana*
k = *Perdicella kuhnsi*

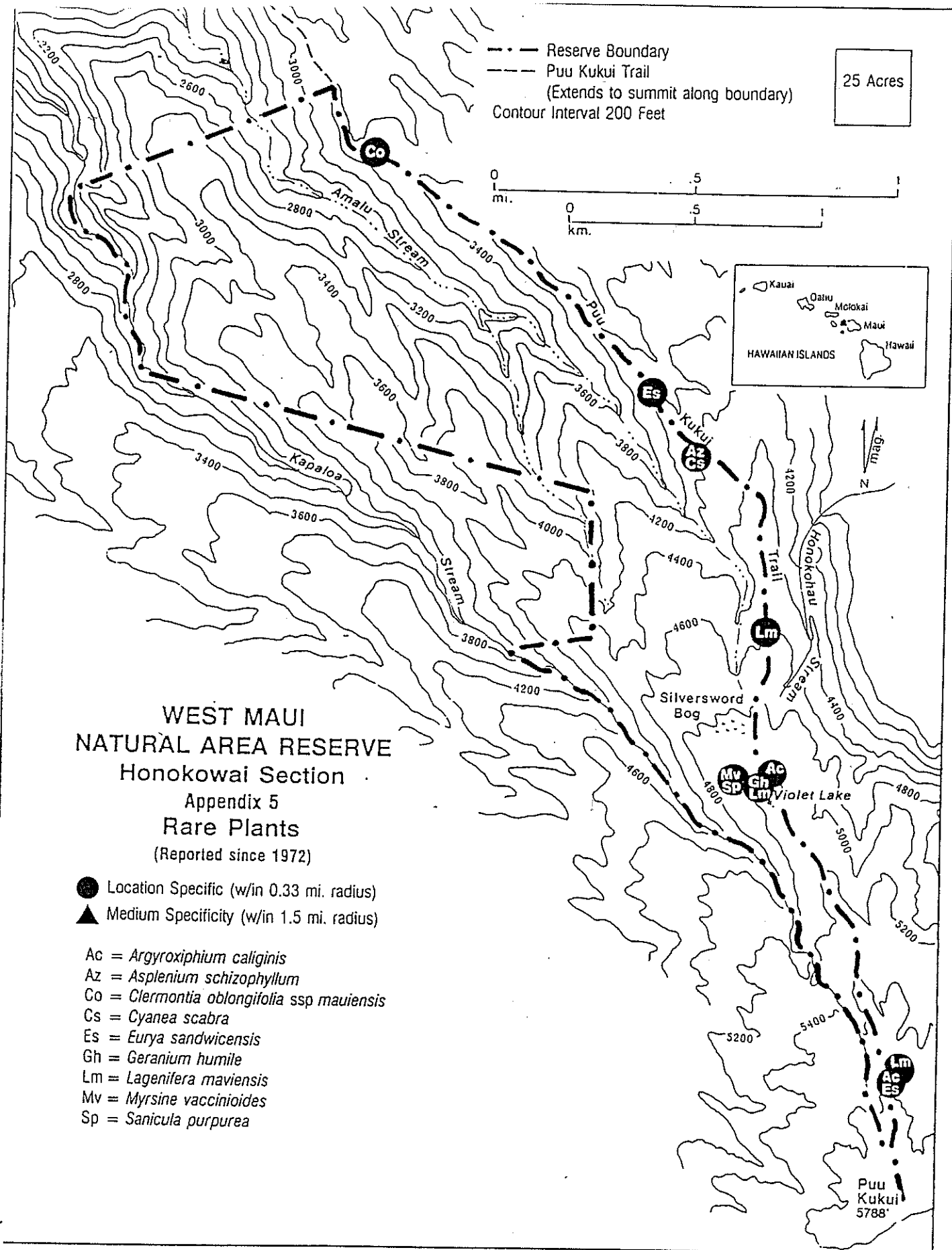


— • — Reserve Boundary
Contour Interval 200 Feet

50 Acres



HAWAIIANS AND

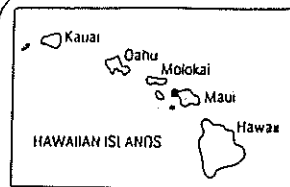


--- Reserve Boundary
 - - - Eke Trail
 Contour Interval 200 Feet

50
Acres

0 .5 1
mi. 0 .5 1
km.

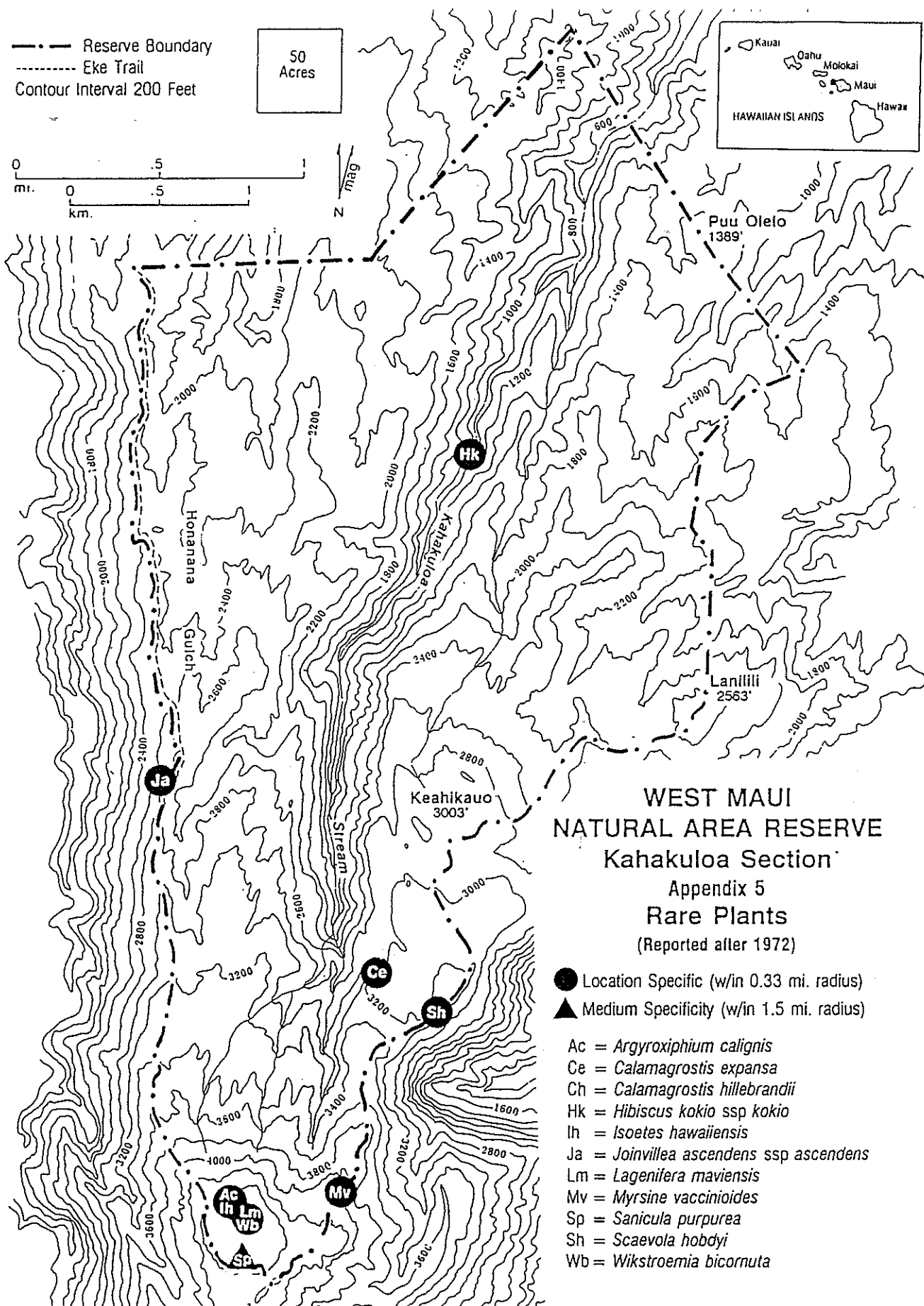
N
mag



WEST MAUI
 NATURAL AREA RESERVE
 Kahakuloa Section
 Appendix 5
 Rare Plants
 (Reported after 1972)

- Location Specific (w/in 0.33 mi. radius)
 ▲ Medium Specificity (w/in 1.5 mi. radius)

Ac = *Argyroxiphium calignis*
 Ce = *Calamagrostis expansa*
 Ch = *Calamagrostis hillebrandii*
 Hk = *Hibiscus kokio* ssp *kokio*
 Ih = *Isoetes hawaiiensis*
 Ja = *Joinvillea ascendens* ssp *ascendens*
 Lm = *Lagenifera maviensis*
 Mv = *Myrsine vaccinioides*
 Sp = *Sanicula purpurea*
 Sh = *Scaevola hobbii*
 Wb = *Wikstroemia bicornuta*



APPENDIX 6
West Maui Area
Bird Species List

The birds listed have been reported from visual and audio identification in or near the reserve. The list includes information on rare birds, compiled from the literature (Scott et al. 1986). Taxonomy follows the Checklist of the Birds of Hawaii by Pyle (1988).

Status	Species	Common name	Source
N	<u>Cardinalis cardinalis</u>	Northern Cardinal	x
N	<u>Carpodacus mexicanus</u>	House Finch	x
N	<u>Cettia diphone</u>	Japanese Bush-warbler	*
N	<u>Garrulax canorus</u>	Hwamei	x
E	<u>Hemignathus virens wilsoni</u>	Amakihi	*
E	<u>Himatione sanguinea sanguinea</u>	Apapane	*
N	<u>Leiothrix lutea</u>	Red-billed Leiothrix	x
N	<u>Lonchura punctulata</u>	Nutmeg Mannikin	x
V	<u>Pluvialis dominica</u>	Kolea	*
N	<u>Streptopelia chinensis</u>	Spotted Dove	*
E	<u>Vestiaria coccinea</u>	I'iwi	*
N	<u>Zosterops japonicus</u>	Japanese White-eye	*

+ = Rare
E = Endemic

N = Non-native
I = Indigenous

V = Visitor

x = Cited in literature * = Confirmed during NARS field study
? = Cited in literature; needs confirmation in reserve

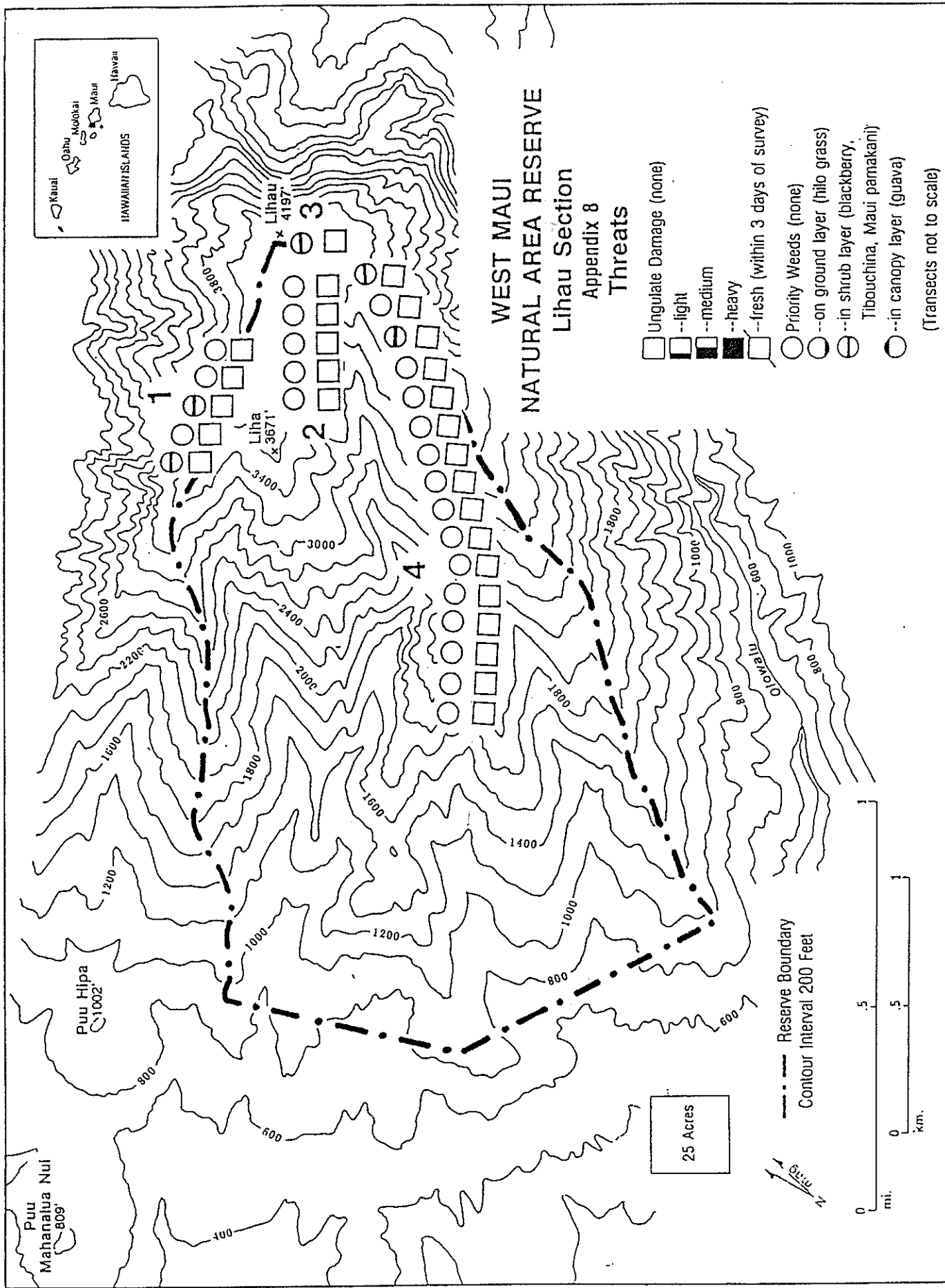
APPENDIX 7
West Maui Natural Area Reserve
Rare Land Snails

Scientific Name	Current Occurrences ¹	HHP Rank ²
<u>Partulina gouldii</u>	1	1
<u>Partulina perdix</u>	3	1
<u>Partulina splendida</u>	3	1
<u>Partulina tappaniana</u>	1	1
<u>Perdicella kuhnsi</u>	1	1

¹ Current occurrences reported since 1972 (Severns n.d.)

² Key to Hawaii Heritage Program Rank:

1 = Critically imperilled globally (typically 1-5 occurrences)



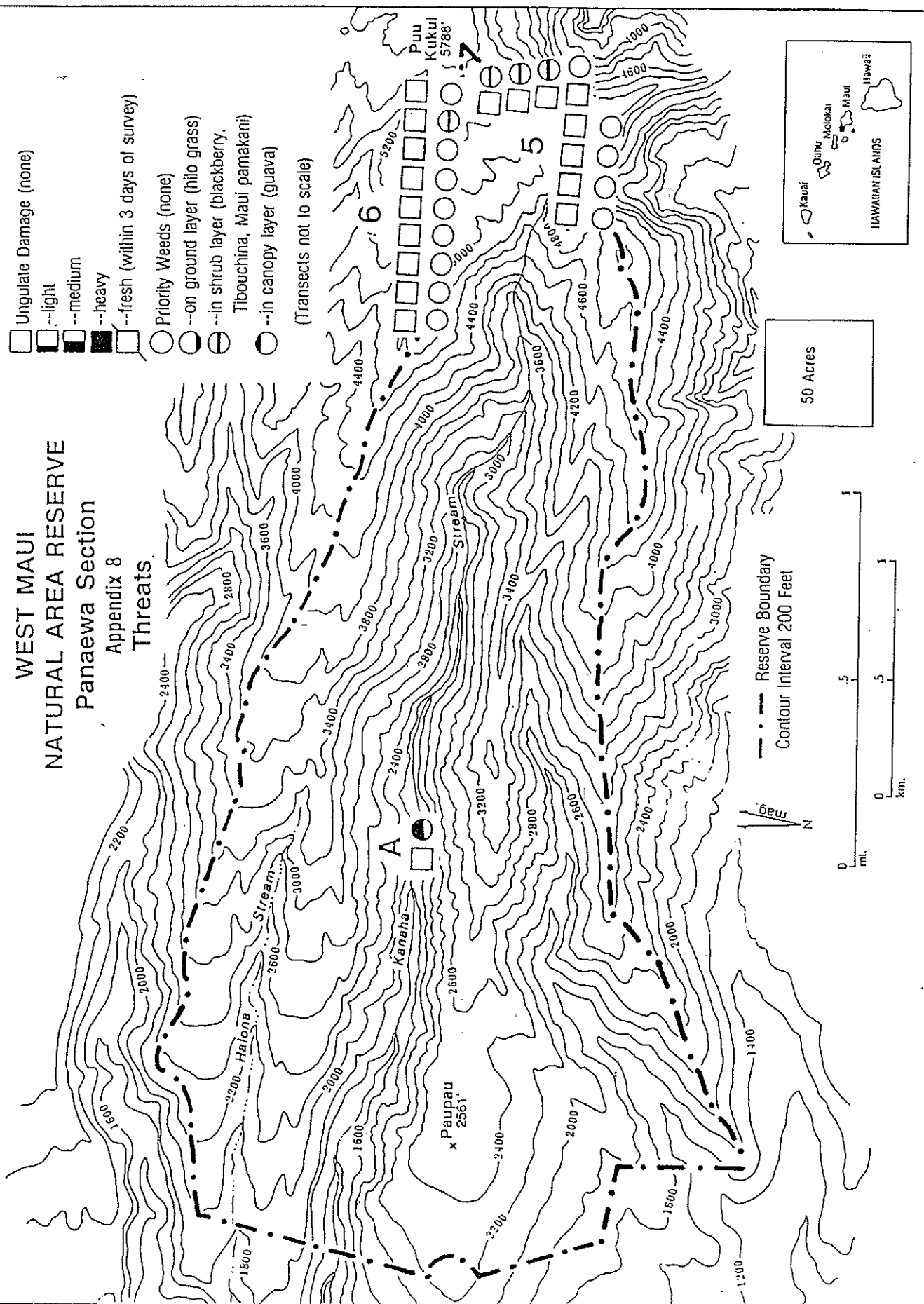
WEST MAUI NATURAL AREA RESERVE Panaewa Section

Appendix 8

Threats

- Ungulate Damage (none)
- ▤ --light
- ▥ --medium
- ▧ --heavy
- ▨ --fresh (within 3 days of survey)
- Priority Weeds (none)
- --on ground layer (hilo grass)
- --in shrub layer (blackberry, Tibouchina, Maui pamakani)
- --in canopy layer (guava)

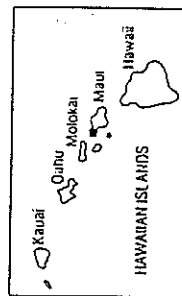
(Transects not to scale)

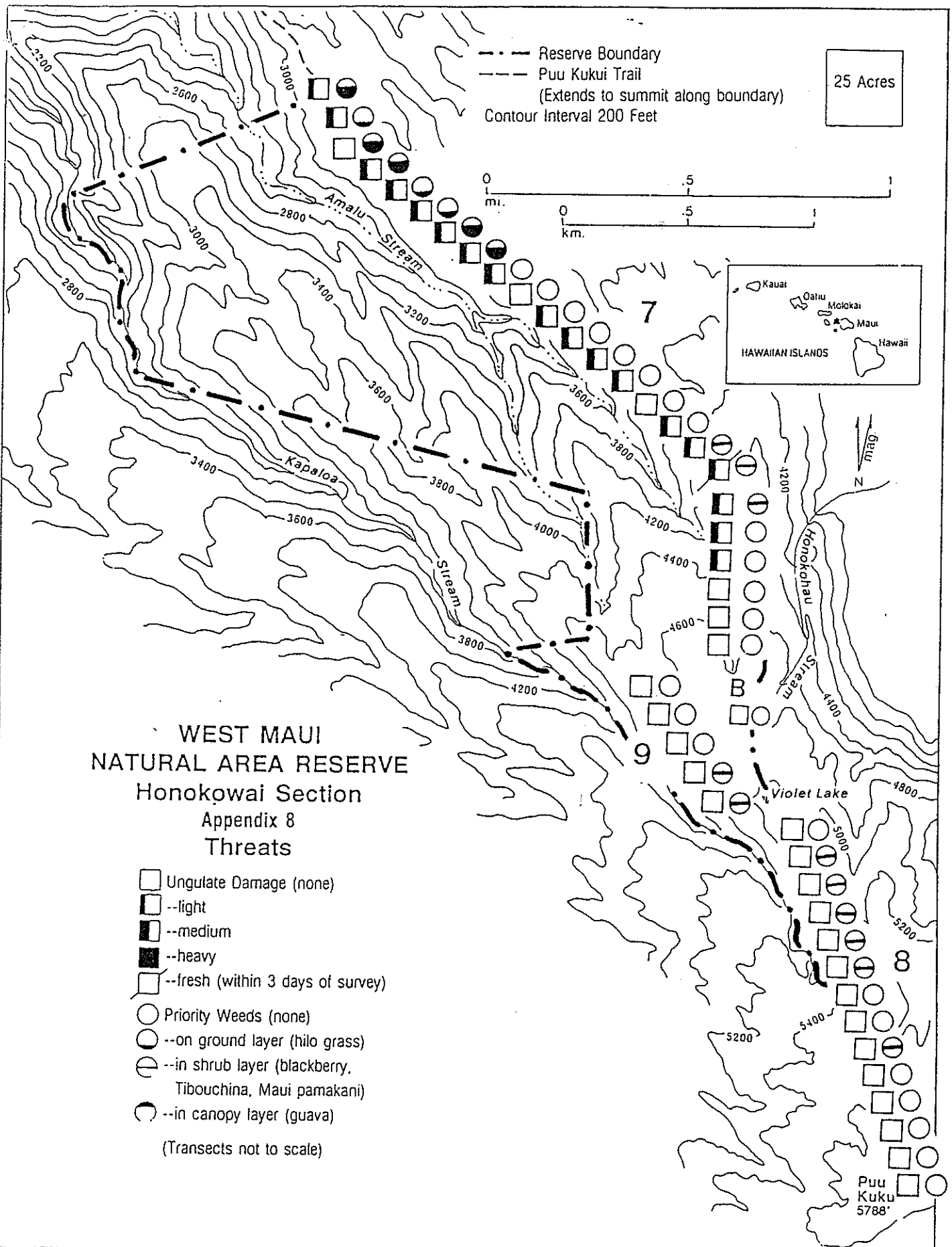


50 Acres

--- Reserve Boundary
Contour Interval 200 Feet

0 1
mi.
0 1
km.



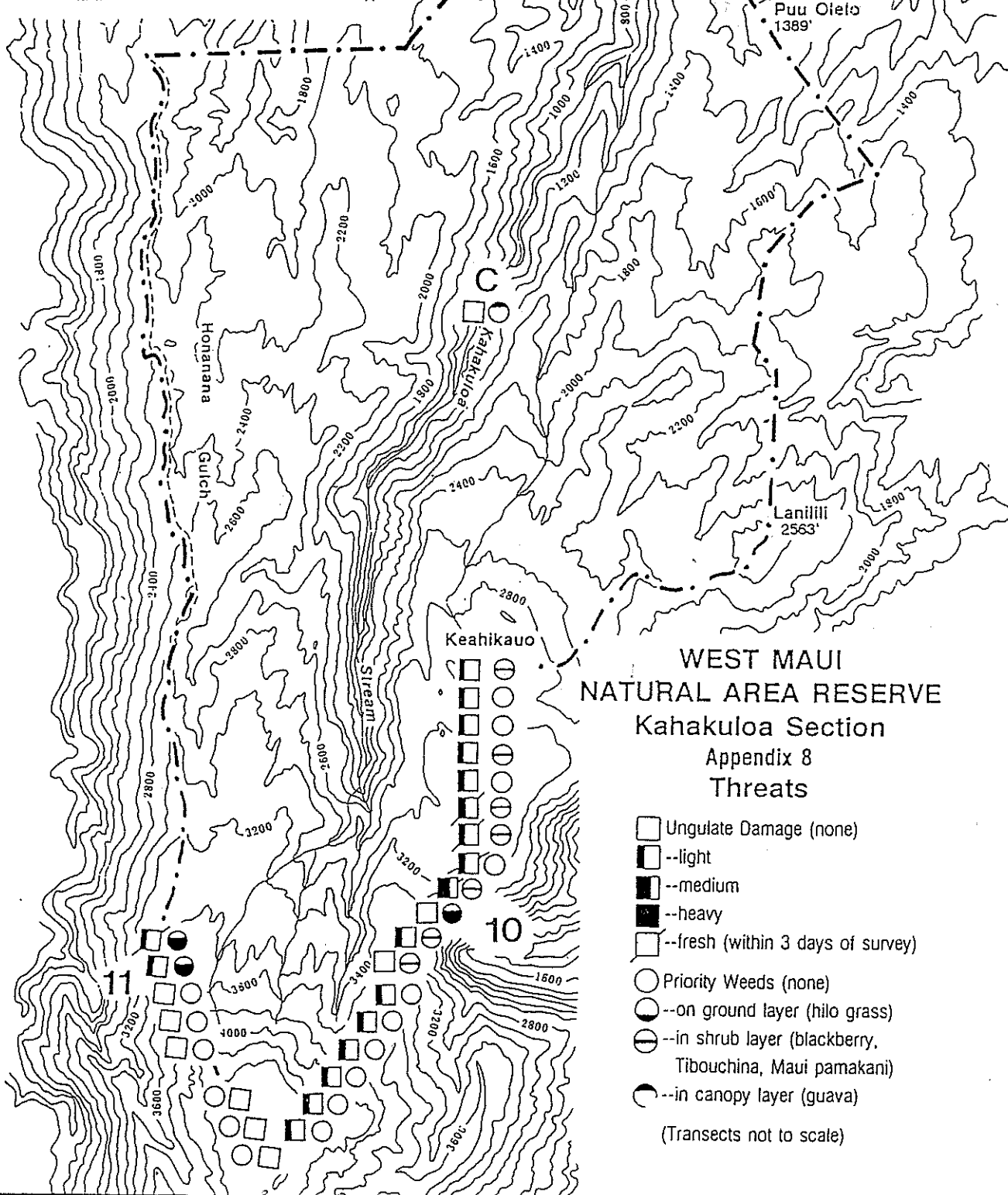
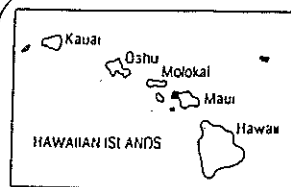


--- Reserve Boundary
 Eke Trail
 Contour Interval 200 Feet

50
Acres

0 .5 1
mi.
0 .5 1
km.

N
mag



WEST MAUI NATURAL AREA RESERVE Kahakuloa Section Appendix 8 Threats

- Ungulate Damage (none)
- ▢ --light
- ▣ --medium
- ▤ --heavy
- ◻ --fresh (within 3 days of survey)
- Priority Weeds (none)
- ◐ --on ground layer (hilo grass)
- ◑ --in shrub layer (blackberry, Tibouchina, Maui pamakani)
- ◒ --in canopy layer (guava)

(Transects not to scale)